

## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What basic subjects do computer engineers study?
- 2 What kind of work are computer engineers trained for?



computer engineer

Kempko Technical Institute >

Department of Computer Engineering >  
Program Overview

## What will I learn in the Computer Engineering Program?

Start your career as a **computer engineer** at Kempko! Our program teaches everything you need to know about computer engineering. This growing field has many career opportunities.

- Begin with fundamental courses in engineering and **computer science**. Gain a strong understanding of **mathematical analysis** and theory.
- Learn to **develop** computer **software**. **Design** your own computer programs. Then other students will **test** them for functionality and usability.
- Also learn to **investigate** problems with **hardware**, **evaluate** causes and implement appropriate solutions. These skills will make you invaluable to potential employers.

mathematical analysis

4

## Reading

2 Read the webpage. Then, mark the following statements as true (T) or false (F).

- 1  Students must study computer science before they apply to the program.
- 2  Computer engineering students test each other's software.
- 3  According to the webpage, the school places students with potential employers.

## Vocabulary

3 Match the words (1-5) with the definitions (A-E).

- |                                    |  |
|------------------------------------|--|
| 1 <input type="checkbox"/> test    | 4 <input type="checkbox"/> evaluate    |
| 2 <input type="checkbox"/> design  | 5 <input type="checkbox"/> investigate |
| 3 <input type="checkbox"/> develop |  |

- A to plan the way that something will be created  
 B to get more information about something  
 C to carefully study and assess the qualities of something  
 D to bring something from conception to action  
 E to operate something to see if it works properly

4 Place the words or phrases from the word bank under the correct headings.

### Word BANK

mathematical analysis   software  
 computer engineer  
 hardware   computer science

Parts of a computer	Computer Studies	People who work with computers



investigate



- 5 Listen and read the webpage again. What parts of a computer do computer engineers work with?

## Listening

- 6 Listen to a conversation between an academic advisor and a student. Choose the correct answers.
- What is the purpose of the conversation?
    - A to review the requirements for computer engineering students
    - B to list different foci within the computer engineering major
    - C to discuss the woman's experience with the computer engineering program
    - D to determine if the man is interested in computer engineering
  - What has the man already completed?
    - A an application to major in computer science
    - B a few mathematical analysis courses
    - C an overview course on hardware and software
    - D an entrance exam for the computer engineering program

- 7 Listen again and complete the conversation.

**Advisor:** Okay, let's look at your next semester. Did you decide on a major?

**Student:** I'm not sure. My 1 \_\_\_\_\_ to go for something with good career potential.

**Advisor:** I see you already took some 2 \_\_\_\_\_ courses.

**Student:** I want to do a course 3 \_\_\_\_\_ solving problems.

**Advisor:** How about the computer engineering program? You will probably do well on the 4 \_\_\_\_\_.

**Student:** I don't know much about that. Do computer engineers focus on 5 \_\_\_\_\_?

**Advisor:** Both, actually. The program teaches 6 \_\_\_\_\_ and electrical engineering.

**Student:** Hmm. That sounds interesting. I'll look into it.

## Speaking

- 8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*My goal is to ...*  
*I see you already took ...*  
*I want to do ...*

**Student A:** You are an academic advisor. Talk to Student B about:

- his or her interest in computer engineering
- which courses he or she has already taken
- subjects that the program covers

**Student B:** You are a student. Talk to Student A about your interest in computer engineering.

## Writing

- 9 Use the conversation from Task 8 to fill out the email from an advisor to a student.

Dear Tim,

I think you would be a great fit for the computer engineering program. You have already taken \_\_\_\_\_.

That means you already know about \_\_\_\_\_.

In the program, you will take \_\_\_\_\_,

where you will learn about \_\_\_\_\_.

You will also learn about \_\_\_\_\_.

Let me know if I can answer any further questions.

Sincerely,

Gina Farrell  
 Academic Advisor  
 Kempko Technical Institute



# 2 Types of Computers

## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What are the benefits of different types of personal computers?
- 2 What types of computers do businesses use?

HOME

ABOUT US

SERVICES

CONTACT

embedded computer

desktop

workstation

laptop

tablet

notebook

Seacrest COMPUTERS

HOME

Seacrest COMPUTERS

ABOUT US

PRODUCTS

Seacrest **Computers** manufactures a variety of products. We mostly create custom **PCs** for individuals. Our **desktops** are great for your home or office. We also create **laptops** and **notebooks** for mobile customers. Don't miss Seacrest's first **tablet**! It is scheduled for release later this year.

Seacrest also has a great product lineup for businesses. Our **servers** are secure and reliable. Your job will become easier with our custom **workstations**. Does your company process a lot of data? Allow us to design your new **computer cluster**. We also install **embedded computers** in company vehicles.



For more information, click here to contact us!



## Reading

2 Read the webpage. Then, mark the following statements as true (T) or false (F).

- 1  The company advertises laptops for mobile customers.
- 2  The company's tablet is one of its most popular products.
- 3  The webpage recommends installing workstations in company vehicles.

## Vocabulary

3 Match the words or phrases (1-6) with the definitions (A-F).

- |                                   |  |
|-----------------------------------|--|
| 1 <input type="checkbox"/> PC     | 4 <input type="checkbox"/> desktop           |
| 2 <input type="checkbox"/> tablet | 5 <input type="checkbox"/> computer cluster  |
| 3 <input type="checkbox"/> laptop | 6 <input type="checkbox"/> embedded computer |

- A a computer designed for individual use
- B a computer intended to be used in a single place
- C a portable, folding computer
- D a computer that is part of a larger product
- E a portable computer with a flat touch screen
- F a computer that can process large amounts of data



**4** Read the sentence pairs. Choose which word best fits each blank.

**1 computer / server**

- A These days, many families have more than one \_\_\_\_\_ at home.
- B All of the company's data is transmitted through a single \_\_\_\_\_.

**2 notebook / workstation**

- A The company uses a \_\_\_\_\_ for advanced graphics design.
- B The student used a \_\_\_\_\_ to write an essay on an airplane.

**5** Listen and read the webpage again. What types of computers does the company create for businesses?

**Listening**

**6** Listen to a conversation between two computer engineers. Choose the correct answers.

- 1 What is the conversation mostly about?
  - A the types of computers that the engineers prefer
  - B how to design particular types of computers
  - C problems that the engineers encountered with a computer
  - D which computers are best for different projects
- 2 Which is the man's favorite computer?
  - A computer cluster                      C desktop
  - B workstation                              D laptop

**7** Listen again and complete the conversation.

**Engineer 1:** Hey, Jack. What's your favorite **1** \_\_\_\_\_ to work on?

**Engineer 2:** I don't know. I'd have to think about it. What's yours, Kate?

**Engineer 1:** I think I **2** \_\_\_\_\_ over other computers.

**Engineer 2:** Really? **3** \_\_\_\_\_ like laptops?

**Engineer 1:** Well, I travel a lot. Laptops are **4** \_\_\_\_\_ and their capabilities are similar to desktops.

**Engineer 2:** That makes sense. I guess I **5** \_\_\_\_\_, because of their power.

**Engineer 1:** I bet you'd really enjoy using **6** \_\_\_\_\_.

**Engineer 2:** Yeah, I think I probably would.

**Speaking**

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

*What's your ...?*  
*I think I prefer ...*  
*I bet you'd ...*

**Student A:** You are an engineer. Talk to Student B about:

- the type of computer he or she prefers to use
- the type of computer you prefer to use
- the benefits of different computers

**Student B:** You are an engineer. Talk to Student A about your favorite computer.

**Writing**

**9** Use the conversation from Task 8 to fill out the customer survey.

**Seacrest Computers Customer Survey:**

What kind of computer did you purchase today?

\_\_\_\_\_

Why did you choose this kind of computer?

\_\_\_\_\_

What kind of computer do you typically use?

\_\_\_\_\_

Why?

\_\_\_\_\_



## Get ready!

1 Before you read the passage, talk about these questions.

- 1 How have computer monitors improved over time?
- 2 What is the purpose of a frame buffer?



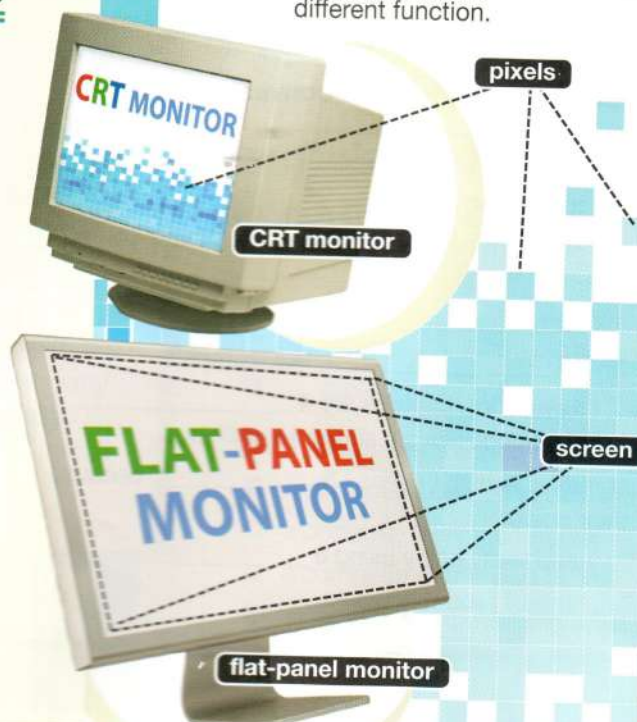
## Chapter 3.2

## Monitors

A **monitor** is a computer **component** that shows images. **Displays** appear on monitor **screens**.

Most of today's monitors have **flat-panel** displays. They usually produce images using **LCDs**. Older monitors used **CRTs**, which made them bulky. As monitors became thinner, image resolution also improved. Current **HD** displays have far better resolution than standard ones. **Active matrices** give monitors this capability.

Displays are made up of many tiny **pixels**. A **bitmap** organizes many pixels into a single image. To display images, computers switch between bitmaps. **Frame buffers** store bitmaps before displaying them on the monitor.



## Reading

2 Read the textbook chapter. Then, mark the following statements as true (T) or false (F).

- 1  Most flat panel monitors use CRTs to display images.
- 2  Active matrices allow monitors to display HD images.
- 3  Multiple bitmaps come together to create a single image.

## Vocabulary

3 Fill in the blanks with the correct words from the word bank.

## Word BANK

CRT screen flat-panel  
component HD pixel

- 1 People can control tablet PCs by touching the \_\_\_\_\_.
- 2 The customer was impressed by the thinness of the \_\_\_\_\_ monitor.
- 3 On very old displays, you could see each individual \_\_\_\_\_.
- 4 Old monitors were bulkier than new ones because they each used a(n) \_\_\_\_\_.
- 5 For the best resolution, get a(n) \_\_\_\_\_ display.
- 6 Each \_\_\_\_\_ of the computer performs a different function.



4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 **bitmap / LCD**

- A The computer's \_\_\_\_\_ is capable of showing detailed, vibrant images.
- B A(n) \_\_\_\_\_ tells pixels on a screen how to form into an image.

2 **active matrix / frame buffer**

- A The display's \_\_\_\_\_ allows it to control each individual pixel.
- B The \_\_\_\_\_ stores bitmaps before the monitor displays them.

3 **display / monitor**

- A Jim's \_\_\_\_\_ is so old that it still uses a CRT.
- B Consumers really like the sharp \_\_\_\_\_ on the new screens.

5 Listen and read the textbook chapter again. How do HD displays differ from standard displays?

## Listening

6 Listen to a conversation between two managers. Choose the correct answers.

- 1 What is the conversation mostly about?
  - A a request for new monitors in an office
  - B which company makes the highest-quality monitors
  - C the type of monitor that a company used to use
  - D a disagreement about which monitors are best
- 2 Which monitor feature does the woman especially like?
  - A flat panel design      C LCD technology
  - B HD resolution      D bitmap display

7 Listen again and complete the conversation.

- Manager 1:** Have you seen 1 \_\_\_\_\_ ?  
They're pretty nice.
- Manager 2:** Yeah. I really like the new 2 \_\_\_\_\_ .
- Manager 1:** It's great. Then again, 3 \_\_\_\_\_ we have flat-panel monitors now.
- Manager 2:** Did the office have those bulky monitors before?
- Manager 1:** Yes. When I started here, we had CRT-based monitors.
- Manager 2:** What's 4 \_\_\_\_\_ ?
- Manager 1:** A cathode ray tube. 5 \_\_\_\_\_ the old monitors so bulky.
- Manager 2:** Oh, yeah. I've seen those. Those took up way 6 \_\_\_\_\_ .

## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

- Have you seen ...?*
- I really like ...*
- It's great.*

**Student A:** You are a manager. Talk to Student B about:

- how monitors have improved
- benefits of the new monitors
- features of the old monitors

**Student B:** You are a manager. Talk to Student A about how monitors have improved.

## Writing

9 Use the conversation from Task 6 to fill out an email from one manager to another manager.

To: d.g@digisyst.com  
From: e.m@digisyst.com  
Subject: New monitors

Hi Dave,

I think we need to get some new monitors for the office. The old ones are \_\_\_\_\_ because \_\_\_\_\_ . I think we should get \_\_\_\_\_ instead. This would be better because \_\_\_\_\_ and \_\_\_\_\_ .

Let me know what you think.

Erica



# 4 I/O Devices 2

## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What information do keyboards and mice input into computers?
- 2 What is the difference between a mechanical mouse and an optical mouse?

## Vanrey 5650 Desktop Computer

What comes with my new computer?

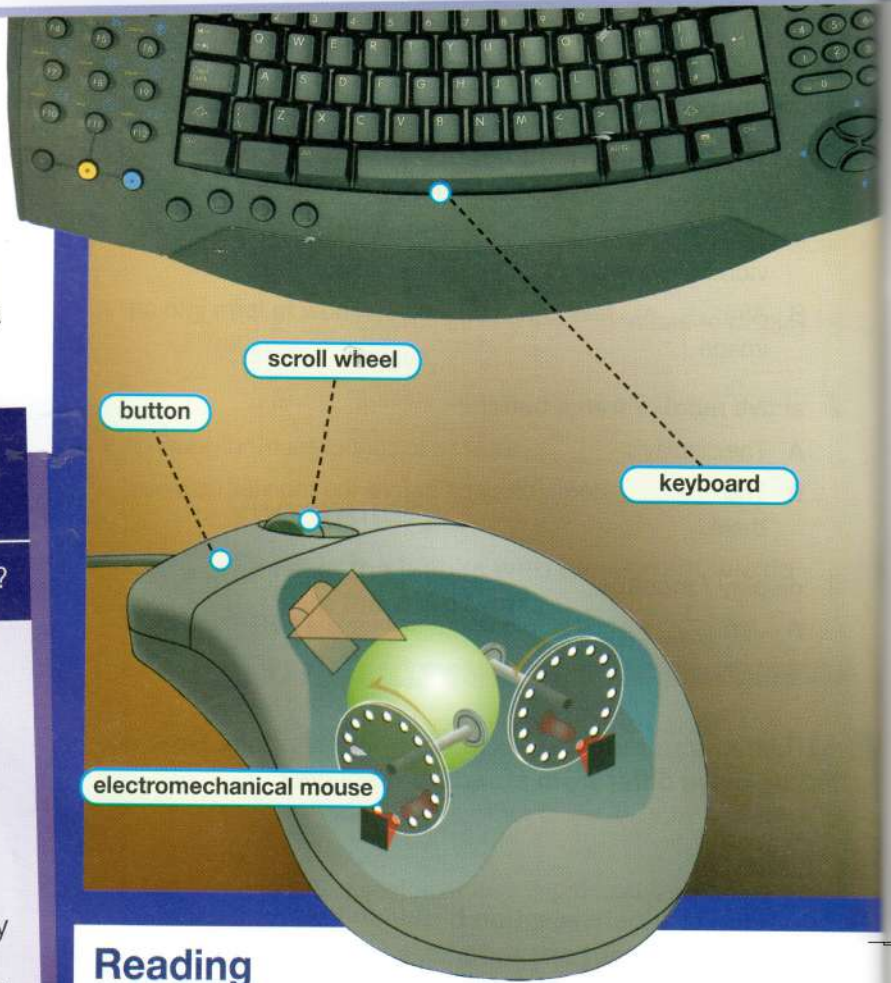
### Included Peripherals

Every desktop model comes with a Vanrey **keyboard**. This **QWERTY** keyboard features new quiet-key technology. It also comes with wrist support to reduce muscle strain.

Each unit also comes with the Vanrey EM750 **electromechanical mouse**. **Scroll** smoothly with a durable **scroll wheel**. Then easily **click** your selections with the two large **buttons**. This standard mouse is perfect for light, everyday use.

### Recommended Peripherals

The Vanrey Omega **optical mouse** tracks movements with **LEDs**. This mouse is recommended for architects, engineers, and other design professionals. It guides **pointers** across **GUIs** with precise, smooth movements. This accessory is sold separately.



## Reading

2 Read the product description. Then, mark the following statements as true (T) or false (F).

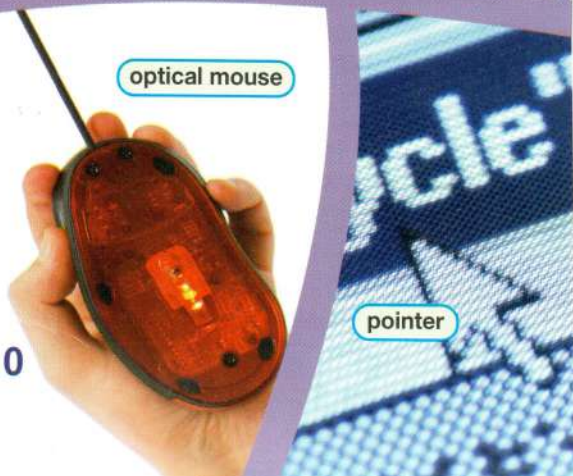
- 1  Users can choose which keyboard the computer comes with.
- 2  An electromechanical mouse is included with the computer.
- 3  The optical mouse is recommended for design professionals.

## Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |                                     |  |
|-------------------------------------|--|
| 1 <input type="checkbox"/> GUI      | 5 <input type="checkbox"/> scroll wheel            |
| 2 <input type="checkbox"/> button   | 6 <input type="checkbox"/> optical mouse           |
| 3 <input type="checkbox"/> pointer  | 7 <input type="checkbox"/> electromechanical mouse |
| 4 <input type="checkbox"/> keyboard | 8 <input type="checkbox"/> peripheral              |

- A an icon on a computer's display controlled by a mouse
- B an input device that uses a ball to track its movement
- C the part of a device that a user presses to perform a function
- D an input device with many keys for inputting data
- E an input device that uses an LED to track its movement
- F a visual display that computer users can interact with
- G a device on a mouse that lets users move up and down smoothly on a screen
- H any device that is connected but not built into a computer





**4** Read the sentence pairs. Choose which word or abbreviation best fits each blank.

**1 scroll / click**

- A Use the button to \_\_\_\_\_ on different selections.
- B The wheel lets users \_\_\_\_\_ smoothly through documents.

**2 QWERTY / LED**

- A The mouse uses a(n) \_\_\_\_\_ to track its movements.
- B Keyboards for English speakers usually have \_\_\_\_\_ layouts.

**5** Listen and read the product description again. What are an electromechanical mouse's main features?

**Listening**

**6** Listen to a conversation between a salesperson and a customer. Choose the correct answers.

- 1 What is the conversation mostly about?
  - A prices for computer accessories
  - B the benefits of a new mouse
  - C a problem with the man's current equipment
  - D why the man prefers his old keyboard
- 2 Which product does the woman recommend?
  - A an optical mouse    C an electromechanical mouse
  - B a new computer    D a QWERTY keyboard

**7** Listen again and complete the conversation.

**Customer:** Hi, I'd like to buy this keyboard.

**Salesperson:** Great! Can I also **1** \_\_\_\_\_ in a new mouse?

**Customer:** No. That's okay. I'm pretty happy with **2** \_\_\_\_\_.

**Salesperson:** Are you sure? What **3** \_\_\_\_\_?

**Customer:** It's an **4** \_\_\_\_\_. It came with my old computer.

**Salesperson:** I think **5** \_\_\_\_\_ an optical mouse. They're much more precise.

**Customer:** Yeah? That could really help me out. I'm a graphic designer.

**Salesperson:** Then you should definitely have the **6** \_\_\_\_\_ . Come take a look.

**Speaking**

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

- I'd like to buy ...*
- I think you'll ...*
- That could really ...*

**Student A:** You are a salesperson. Talk to Student B about:

- peripherals for a computer
- your recommendation
- how he or she will benefit from your recommendation

**Student B:** You are a customer. Talk to Student A about peripherals for your computer.

**Writing**

**9** Use the conversation from Task 8 to fill out the customer feedback form.

**Computers Direct**

**Customer Feedback Form**

What did you purchase?

\_\_\_\_\_

\_\_\_\_\_

Was the salesperson helpful? **Y / N**

Why or why not?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



# 5 Storage Devices

COMPU-LIVING MONTHLY

## Let's Talk Storage!



Computer technology grows rapidly. The **capacity** of data **storage** is no exception. **Hard drives** and storage devices improve all the time.

Early computers relied on **magnetic tape**. Developers soon replaced these with more efficient **floppy disks**. However, these still had limited space. For a while, **Zip® drives** were a larger-capacity solution.

Then **CDs** came along. These lightweight, inexpensive devices are easy to store and discard. **DVDs** have similar benefits, and hold much more data. However, erasing and reprogramming these devices is often unreliable.

Today, we have compact **flash memory**. Tiny **flash drives** hold more information than earlier devices, including DVD's. Unlike most DVD's and CD's, flash drives are easily erasable.



### Get ready!

- 1 Before you read the passage, talk about these questions.
  - 1 What are some early forms of computer data storage?
  - 2 What are the benefits of flash memory?

### Reading

- 2 Read the article. Then, choose the correct answers.
  - 1 What is the main idea of the article?
    - A the rising costs of data storage devices
    - B a history of data storage devices
    - C materials used to make data storage devices
    - D addressing problems with data storage devices
  - 2 Which of the following is NOT a benefit of CDs?
    - A They are easy to store.
    - B They are lightweight.
    - C They can be erased and reprogrammed.
    - D They have a lower capacity than DVD's.
  - 3 According to the article, what makes Zip® drives better than floppy disks?
    - A a smaller size
    - B more affordable cost
    - C a higher capacity
    - D the ability to be erased

### Vocabulary

- 3 Write a word or phrase that is similar in meaning to the underlined part.
  - 1 The engineer could not erase the data from the flat, round data device.  
\_ \_ \_ \_
  - 2 Most new computers cannot read flat, square, low-capacity data devices.  
\_ l o \_ \_ \_ d \_ \_ k s
  - 3 The firm needs a new method of saving information for its electronic files.  
s \_ \_ r a \_ \_
  - 4 New devices have more space to store information than old devices.  
\_ a \_ a \_ i t \_



**4** Read the sentence pairs. Choose which word or phrase best fits each blank.

**1** hard drive / flash drive

- A A \_\_\_\_\_ is built into a computer.  
 B A \_\_\_\_\_ is designed to move easily from one computer to another.

**2** flash memory / magnetic tape

- A \_\_\_\_\_ was one of the earliest methods of computer data storage.  
 B \_\_\_\_\_ has a larger storage capacity than earlier methods, like DVDs.

**3** CDs / Zip® drives

- A \_\_\_\_\_ were popular because they were cheap and disposable.  
 B \_\_\_\_\_ were popular because they were like large-capacity floppy disks.

**5** Listen and read the article again. What product does the article recommend?

**Listening**

**6** Listen to a conversation between a customer and a salesperson. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The man needs help choosing a new hard drive.
- 2 \_\_\_ The man requests a product that will not meet his storage needs.
- 3 \_\_\_ According to the woman, the man needs multiple storage devices.

**7** Listen again and complete the conversation.

**Customer:** Excuse, me. Can you help me **1** \_\_\_\_\_ some CDs?  
**Salesperson:** Of course. What do you need them for?  
**Customer:** Data storage. I'm moving about ten gigabytes off my employer's **2** \_\_\_\_\_.  
**Salesperson:** That's going to take a lot of CDs. I'd recommend a **3** \_\_\_\_\_ instead.  
**Customer:** Why is that better?  
**Salesperson:** I **4** \_\_\_\_\_ with a sixteen-gigabyte capacity.  
**Customer:** Oh, so all the data will fit on **5** \_\_\_\_\_?  
**Salesperson:** Right. Plus, you can **6** \_\_\_\_\_ later and use it for something else.

**Speaking**

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

*Can you help me ...?  
 What do you need ...?  
 Plus, you can ...*

**Student A:** You are a customer.

Talk to Student B about:

- your data storage needs
- a product you are looking for
- his or her recommendations

**Student B:** You are a salesperson.

Talk to Student A about his or her data storage needs.

**Writing**

**9** Use the conversation from Task 8 to fill out the note from the customer to his or her employer.



Hi Jenny,

I picked up a storage device at the electronics store today. I know you said that you wanted \_\_\_\_\_ . However, I got \_\_\_\_\_ instead. The salesperson recommended that because \_\_\_\_\_ and \_\_\_\_\_ . I hope that's okay.

Glenn



## Get ready!

1 Before you read the passage, talk about these questions.

- 1 Why do computers have fans and heat sinks?
- 2 What is the purpose of a computer bay?

## Reading

2 Read the troubleshooting guide. Then, mark the following statements as true (T) or false (F).

- 1 \_\_\_ According to the guide, the most likely cause of overheating is a problem with the fan.
- 2 \_\_\_ The first troubleshooting step is to disconnect the fan from the motherboard.
- 3 \_\_\_ According to the guide, malfunctioning fans produce additional heat.

## Vocabulary

3 Match the words or phrases (1-6) with the definitions (A-F).

- |             |                    |
|-------------|--------------------|
| 1 ___ fan   | 4 ___ processor    |
| 2 ___ bay   | 5 ___ motherboard  |
| 3 ___ cover | 6 ___ CD/DVD drive |

- A a device that makes something cooler by moving air
- B a part of a computer that interprets and runs programs
- C a part of something that protects its interior components
- D a location where hardware is stored inside a computer
- E a part of a computer that reads disc-based media
- F a computer's central circuit board



## Troubleshooting Guide

### Overheating

The most common cause of overheating is a malfunctioning **fan**. Most computers have a **heat sink**. This has its own fan. Other computers have a separate fan in the **case**.

To troubleshoot overheating, first remove the computer's **cover**. Then check whether the fan is functioning.

- If the fan is not functioning, check the **power supply**. Some fans attach to the **motherboard**. Others connect directly to the PSU. Reconnect it to the proper **port** if it is disconnected.
- If the fan is functioning, it may be inadequate. Additional hardware installations produce extra heat. Check **bays** for heat from added **processors** or **CD/DVD drives**. In this situation, you may need to purchase a stronger fan.





4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 heat sink / power supply

- A The computer's \_\_\_\_\_ regulates the computer's temperature.
- B The computer won't turn on without a \_\_\_\_\_.

2 case / port

- A To connect the monitor, make sure the cable is in the right \_\_\_\_\_.
- B The computer has a clear \_\_\_\_\_ so users can see the interior components.

5 Listen and read the troubleshooting guide again. What is the first step when troubleshooting an overheating computer?

## Listening

6 Listen to a conversation between a technician and a customer. Choose the correct answers.

- 1 What is the purpose of the conversation?
  - A to determine why a computer will not turn on
  - B to discuss a possible solution to a temperature problem
  - C to explain why some hardware components are more effective than others
  - D to record a formal complaint about a manufacturer's product
- 2 What will the woman likely do next?
  - A replace the central processor
  - B move hardware to other bays
  - C reconnect the fan to the port
  - D open the computer's case

7 Listen again and complete the conversation.

**Technician:** This is tech support. How may 1 \_\_\_\_\_ ?

**Customer:** My computer 2 \_\_\_\_\_.

**Technician:** Have you checked whether 3 \_\_\_\_\_ working?

**Customer:** Yes. I opened 4 \_\_\_\_\_, and I can see the fan spinning.

**Technician:** Go ahead and try moving the hardware to different bays.

**Customer:** How would that help?

**Technician:** It helps to 5 \_\_\_\_\_ from other heat-producing hardware.

**Customer:** Okay. I'll call back if that 6 \_\_\_\_\_.

## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*Have you checked ...?*  
*Yes. I opened the case and ...*  
*Go ahead and do that.*

**Student A:** You are a technician. Talk to Student B about:

- a problem with his or her computer
- what he or she has already tried
- possible solutions to the problem

**Student B:** You are a customer. Talk to Student A about fixing your computer.

## Writing

9 Use the conversation from Task 8 to fill out the tech support log.

### Tech Support Log

Customer ID: \_\_\_\_\_

Problem: \_\_\_\_\_  
 \_\_\_\_\_

Actions already taken: \_\_\_\_\_  
 \_\_\_\_\_

Actions recommended: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_



## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What are some different types of networks?
- 2 What is the difference between a router and a modem?

## Reading

2 Read the webpage. Then, mark the following statements as true (T) or false (F).

- 1  The bronze package includes a wireless network.
- 2  The silver package connects computers through a router.
- 3  The gold package is the least expensive option.

## Vocabulary

3 Match the words or abbreviations (1-6) with the definitions (A-F).

- |                                   |                                     |  |
|-----------------------------------|-------------------------------------|--|
| 1 <input type="checkbox"/> LAN    | 3 <input type="checkbox"/> WLAN     | 5 <input type="checkbox"/> wireless    |
| 2 <input type="checkbox"/> signal | 4 <input type="checkbox"/> Internet | 6 <input type="checkbox"/> CAT-5 cable |

- A a large network that reaches all over the world  
 B a small network of computers that are connected by cables  
 C a collection of information transmitted by hardware  
 D not requiring or involving wires  
 E a type of cable used to create computer networks  
 F a small network of computers that are connected wirelessly

www.linkoconnect.com/services —  
Linko Connect | Products and Services

HOME ABOUT US SERVICES CONTACT

## LinkoConnect

Linko Connect provides a wide variety of products and services. Are you in need of a **network**? Linko Connect has many different networking packages.

Get our lowest available price with the **bronze package**. Link multiple home or office computers together with a **LAN**. We use enhanced **CAT-5 cables** to connect your machines.

Don't like wires and cables? Don't worry! With our **silver package** you'll get a **WLAN**. Our **wireless** networks transmit **signals** through a central **router**. Each router's **antenna** can transmit signals from blocks away.

Finally, our **gold package** includes our best high speed **broadband**. You'll surf the **Internet** at 50 Mbps!

All packages come with separate or built-in **modems**.

www.linkoconnect.com





4 Read the sentence pairs. Choose which word best fits each blank.

1 modem / antenna

- A A computer uses a(n) \_\_\_\_\_ to connect to the telephone line.  
 B Some devices receive wireless signals through a(n) \_\_\_\_\_.

2 router / network

- A The computers are all part of the same \_\_\_\_\_.  
 B A \_\_\_\_\_ directs information to the computers it is connected to.

5 Listen and read the webpage again. What kind of network is available with the bronze package?

## Listening

6 Listen to a conversation between a representative and a customer. Choose the correct answers.

- 1 What is the conversation mostly about?  
 A a problem with a network connection  
 B the most appropriate Internet package  
 C the benefits of purchasing an additional product  
 D the costs of different connection speeds
- 2 Why does the woman decline a particular product?  
 A She thinks it is too expensive.  
 B She does not want wireless access.  
 C She wants a better connection speed.  
 D She already has the product.

7 Listen again and complete the conversation.

- Representative:** This is Linko Connect. How may I help you?  
**Customer:** I'm interested in an 1 \_\_\_\_\_. What are my options?  
**Representative:** Well, our gold package comes with 2 \_\_\_\_\_ . And its connection speed is forty megabits per second.  
**Customer:** I don't need that. 3 \_\_\_\_\_ a router.  
**Representative:** In that case, 4 \_\_\_\_\_ basic package. It doesn't come with a router.  
**Customer:** But is it 5 \_\_\_\_\_ ?  
**Representative:** Yes, it's the same speed. You'll just 6 \_\_\_\_\_ on the router.  
**Customer:** Great. I'll take that.

## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

- How may I help you?*  
*I don't need ...*  
*I recommend ...*

**Student A:** You are a representative for an Internet service provider. Talk to Student B about:

- his or her Internet connection options
- his or her Internet needs
- your recommendation

**Student B:** You are a customer. Talk to Student A about Internet connection options.

## Writing

9 Use the conversation from Task 8 to fill out the order form.

### LinkoConnect Service Order Form

Customer Name: \_\_\_\_\_

Customer ID: \_\_\_\_\_

Order: \_\_\_\_\_

This package includes: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_



## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What are some commonly used operating systems?
- 2 What are the benefits of an operating system that you use?



Dear Mr. Tech,  
I'm considering buying a new computer. However, I don't know which **operating system** to choose. Which one do you recommend?  
James in Glenwall

Dear James,  
Each operating system (OS) has different benefits. **Apple®** produces a popular OS called **OS X®**. This system has fewer known viruses than other systems. **Microsoft®** makes an OS called **Windows®**. One of its benefits is **software compatibility**. Windows works with a wide variety of programs. Finally, there is also the **Linux®** OS. Linux® is **open source** and easy to **customize**. I hope this helps you make your decision!  
Mr. Tech

## Reading

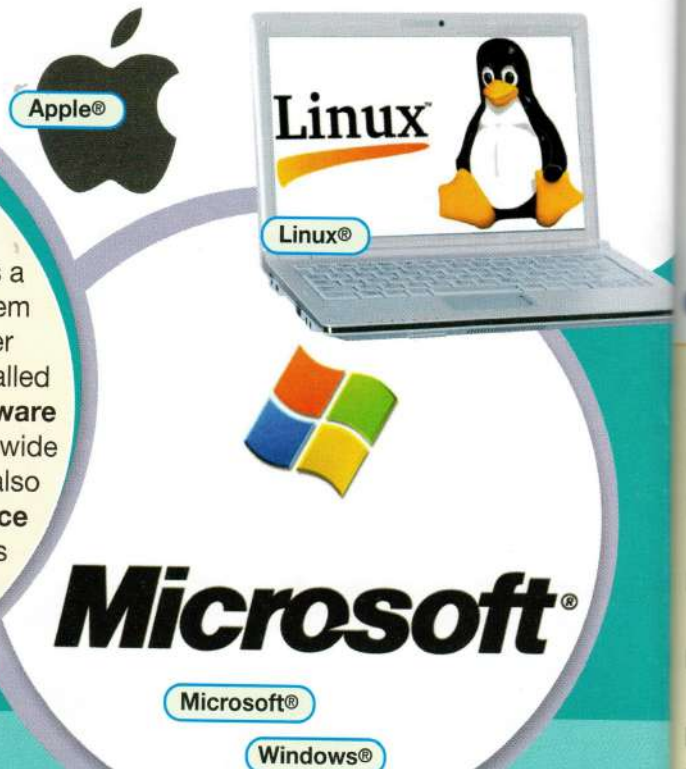
2 Read the advice column. Then, complete the table.

Operating System	Benefit
1 _____	Has fewer known viruses.
Windows®	2 _____ _____
Linux®	3 _____ _____

## Vocabulary

3 Write a word that is similar in meaning to the underlined part.

- 1 The new computer was made by a company that produces both operating systems and computers.    \_ \_ p l \_ ®
- 2 The engineer works for the company that makes the Windows operating system.    M \_ \_ \_ o \_ o \_ \_ ®
- 3 Some people prefer an open source operating system.    \_ i n \_ \_
- 4 The operating system made by Apple® is popular for its virus security.    \_ \_ \_
- 5 The operating system made by Microsoft® is popular for its wide range of uses.    \_ \_ n d \_ \_ s ®





- 4 Fill in the blanks with the correct words or phrases from the word bank.

## Word BANK

operating system    open source  
customize    software compatibility

- The source code for \_\_\_\_\_ software is freely available.
- \_\_\_\_\_ determines whether a computer can run certain programs.
- Most complex computers cannot function without a(n) \_\_\_\_\_.
- Many people like to \_\_\_\_\_ software to fit particular needs.

- 5 Listen and read the advice column again. Which company's operating system is least likely to get a virus?

## Listening

- 6 Listen to a conversation between two computer engineers. Choose the correct answers.

- What is the conversation mostly about?
  - which software a particular operating system can run
  - which companies produce different operating systems
  - which operating system has the best features
  - which operating system is the easiest to install
- What is true about the man?
  - He dislikes the Windows® operating system.
  - He likes a larger software selection.
  - He prefers the system that's less likely to get a virus.
  - He wants a system that is more customized.

- 7 Listen again and complete the conversation.

Engineer 1: Hey, you prefer OS X® 1 \_\_\_\_\_, don't you?

Engineer 2: Not at all. Windows® is my favorite 2 \_\_\_\_\_.

Engineer 1: Really? I'm surprised.

Engineer 2: What's surprising about it? Windows® has great 3 \_\_\_\_\_.

Engineer 1: Perhaps, but OS X® is less 4 \_\_\_\_\_ viruses.

Engineer 2: I see where 5 \_\_\_\_\_ . But I prefer a large software library.

Engineer 1: But don't you agree that OS X® is better all around?

Engineer 2: Nope. I guess we have to 6 \_\_\_\_\_ .

## Speaking

- 8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*I prefer ...*

*But wouldn't you agree that ...?*

*We have to agree to disagree.*

**Student A:** You are an engineer. Talk to Student B about:

- your favorite operating system
- his or her favorite operating system
- the advantages of each operating system

**Student B:** You are an engineer. Talk to Student A about your favorite operating system.

## Writing

- 9 Use the conversation from Task 8 to fill out an email from a computer engineer to a client.

Dear \_\_\_\_\_,

I heard that the office is getting new computers. Did you choose an operating system yet? I recommend \_\_\_\_\_ because \_\_\_\_\_ . Some people in the office would prefer \_\_\_\_\_ because \_\_\_\_\_ . Let me know what you decide.

Regards,

\_\_\_\_\_  
Computer Engineer



## Get ready!

- Before you read the passage, talk about these questions.
  - What are some different ways to describe combining numbers?
  - What are some different ways to describe splitting numbers apart?

1,400

-hundred

## How do they say it?

Symbol	Interpretation	Examples
=	equals	$\frac{1}{4} = 0.25$ One quarter equals point two five.
+	plus, add	$A + B = C$ A plus B equals C. Add A and B to get C.
-	minus, less, subtract	$A - B = C$ A minus B is C. Subtract B from A to get C.
×	multiplied by, times	$A \times B = C$ A multiplied by B is C. A times B equals C.
÷, /	divided by, over	$A \div B = C$ A divided by B equals C. $A / B = C$ A over B is C.
1,900	one thousand nine hundred or nineteen hundred	We spent nineteen hundred dollars on office supplies.

## Reading

- Read the chart. Then, mark the following statements as true (T) or false (F).
  - Four times seven equals seven minus four.
  - Two plus three equals five.
  - Six divided by three is the same as six over three.

## Vocabulary

- Read the sentences and choose the correct words or phrases.
  - Five **less** / **plus** three equals two.
  - Eight **divided by** / **times** two equals four.
  - Subtract** / **Equal** one number from another to find the difference between them.
  - Two **multiplied by** / **divided by** three is six.
  - If you **add** / **subtract** two amounts of something, you get a larger amount.

$$2 + 3 = 5$$

plus

$$3 - 2 = 1$$

minus

$$2 \times 3 = 6$$

times

$$6 \div 2 = 3$$

divided by

$$4 + 3 = 7$$

equals



- 4 Place the correct words from the word bank under the correct headings.

**Word BANK**

equal minus times plus over

Combining amounts	Splitting amounts	Expressing results

- 5 Listen and read the chart again. What is the result if someone multiplies two quantities instead of dividing them?

**Listening**

- 6 Listen to a conversation between two engineering students. Choose the correct answers.

- What is the main idea of the conversation?
  - A why the man got the wrong answer to a test question
  - B which student got a higher grade on a test
  - C when the students will be tested on new math concepts
  - D how the woman's test score was calculated
- Which operation was required in the first part of the equation?
  - A dividing                      C subtracting
  - B adding                        D multiplying

- 7 Listen again and complete the conversation.

**Student 1:** How did you do on the 1 \_\_\_\_\_ ?

**Student 2:** I missed something on the first part. I don't know what I 2 \_\_\_\_\_ .

**Student 1:** Let's see. The equation started with fourteen hundred 3 \_\_\_\_\_ .

**Student 2:** So 4 \_\_\_\_\_ five equals seven thousand, right?

**Student 1:** No, that's not it. You 5 \_\_\_\_\_ instead of dividing.

**Student 2:** Oh, of course. I get it now. It 6 \_\_\_\_\_ fourteen hundred over five.

**Speaking**

- 8 With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

*I don't know what I did...  
You ... instead of ... / I get it now.*

**Student A:** You are an engineering student. Talk to Student B about:

- his or her performance on a math test
- a question he or she answered incorrectly
- the mathematical operation he or she should have used

**Student B:** You are an engineer student. Talk to Student A about your performance on a math test.

**Writing**

- 9 Use the conversation from Task 8 to fill out the test revision sheet.

**Course: Math 100**

**Student:**

Please write the equation you missed. Then, explain what you did wrong and write the corrected equation.

Incorrect Equation	What did you do wrong?	Corrected Equation
1. $4 - 1 = 3$	I subtracted instead of adding.	$4 + 1 = 5$
2. $1,400 \times 5 = 7,000$	I multiplied instead of dividing.	_____
3. _____	I subtracted instead of adding.	$1,500 + 500 = 2,000$



# 10 Analyzing Quantities

## Get ready!

- 1 Before you read the passage, talk about these questions.
  - 1 How are fractions expressed?
  - 2 How are percentages expressed?

## Reading

- 2 Read the textbook chapter. Then, mark the following statements as true (T) or false (F).

- 1 \_\_\_ The numerator of a fraction expresses the total units possible.
- 2 \_\_\_ Percentages can be expressed as whole or decimal numbers.
- 3 \_\_\_ A percentage as a numerator over 100 is a fraction.

## Vocabulary

- 3 Match the words (1-6) with the definitions (A-F).

- 1 \_\_\_ point
  - 2 \_\_\_ percent
  - 3 \_\_\_ -out of
  - 4 \_\_\_ numerator
  - 5 \_\_\_ denominator
  - 6 \_\_\_ decimal number
- A the number above the line on a fraction  
B the number below the line on a fraction  
C describing the ratio between actual and potential quantities  
D the quantity of something expressed in terms of 100  
E a dot that separates whole and partial numbers  
F a number with whole and partial numbers separated by a dot

## 10.1 Quantities Expressed in Engineering

Numbers appear in multiple forms. Some quantities are expressed in **fractions**.

Example: 4 **out of** every 5 people in a region have home computers. Therefore,  $\frac{4}{5}$  of people have home computers.

The same number can be a **percentage**.

Example: 80 **percent** of people have home computers.

Percentages sometimes appear as **decimal numbers**. In this case, the percentage comes after a zero and a **point**.

Example: 0.80 of people have home computers.

It is easy to **convert** a percentage to a fraction. Simply use the percentage as a **numerator** and 100 as the **denominator**. Then, **reduce** the fraction to its lowest form.

Example: 80 over 100 equals 4 over 5.



$\frac{1}{4}$

fraction



$\frac{1}{4}$

denominator



$\frac{1}{4}$

numerator



25%

percentage



0.25

decimal number



0.40

point



**4** Read the sentence pairs. Choose which word best fits each blank.

**1** fraction / percentage

- A The denominator of a \_\_\_\_\_ is the number on the bottom.  
 B The \_\_\_\_\_ stated the quantity as a number out of one hundred.

**2** convert / reduce

- A The student attempted to \_\_\_\_\_ the fraction to its lowest form.  
 B The student explained how to \_\_\_\_\_ fractions to percentages.

**5** Listen and read the textbook chapter again. How are percentages expressed as decimal numbers?

## Listening

**6** Listen to a conversation between a student and an instructor. Choose the correct answers.

- 1 What is the conversation mostly about?  
 A a conversion error that the woman made on a test  
 B the benefits of expressing numbers as percentages  
 C how to convert a number into a fraction  
 D the importance of including points in decimal numbers
- 2 What does the man remind the woman to do?  
 A remove points from whole numbers  
 B reduce fractions to the lowest forms  
 C convert whole numbers into decimal numbers  
 D use a percentage as a denominator

**7** Listen again and complete the conversation.

**Student:** Mr. Logan, could you help me with something?

**Instructor:** Of course. What **1** \_\_\_\_\_?

**Student:** I'm having trouble converting **2** \_\_\_\_\_ fractions.

**Instructor:** Just make a fraction with 100 as **3** \_\_\_\_\_ and the percentage as the numerator.

**Student:** So the decimal number is 0.75. I **4** \_\_\_\_\_  
 \_\_\_\_\_ 100?

**Instructor:** Not exactly. You need to convert the percentage into a **5** \_\_\_\_\_.

**Student:** Oh, of course. So it's 75 over 100.

**Instructor:** Exactly. Then **6** \_\_\_\_\_ reduce the fraction to its lowest form.

## Speaking

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

*What do you need?*

*I'm having trouble ...*

*Don't forget to ...*

**Student A:** You are a student. Talk to Student B about:

- your difficulty performing a conversation
- a number you are trying to convert

**Student B:** You are an instructor. Talk to Student A about converting numbers.

## Writing

**9** Use the conversation from Task 8 to fill out the student's notes.

### Number

### Notes

### Conversions:

- To convert a percentage into a decimal number, simply put \_\_\_\_\_  
 \_\_\_\_\_.
- To convert a decimal number into a percentage, simply remove \_\_\_\_\_  
 \_\_\_\_\_.



## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What units of measurement do people use in your country?
- 2 What advantages does the metric system have compared to the imperial system?

## Imperial VS Metric UNITS CONVERSION CHART

Don't know the difference between a pound and a kilogram? This chart will help you figure it out!

**IMPERIAL UNITS** 1 pound = 0.453 kilos



**METRIC UNITS** 1 kilo = 2.205 pounds

### Measurements of Temperature

Use the following formula to convert **degrees** in **Fahrenheit** (°F) to **Celsius** (°C):  $^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times \frac{5}{9}$

### Measurements of Weight

1 **pound** = .45 **kilograms**  
1 **ounce** = 28.35 **grams**

### Measurements of Length

1 **inch** = 2.54 **centimeters**

To **convert** a measurement from imperial units to the metric system, just multiply.  
5 inches to centimeters:  $5 \times 2.54 = 12.7$  centimeters.

To convert a measurement from metric units to imperial units, just divide.  
12 kilograms to pounds:  $12 \div .45 = 26.67$  pounds.

## Reading

2 Read the conversion chart. Then, mark the following statements as true (T) or false (F).

- 1  A two-pound object is heavier than a two-kilogram object.
- 2  A gram of matter is equal to several ounces.
- 3  To calculate inches, someone can divide a number of centimeters by 2.54.

## Vocabulary

3 Match the words (1-7) with the definitions (A-G).

- |                                     |                                       |
|-------------------------------------|---------------------------------------|
| 1 <input type="checkbox"/> ounce    | 5 <input type="checkbox"/> kilogram   |
| 2 <input type="checkbox"/> metric   | 6 <input type="checkbox"/> centimeter |
| 3 <input type="checkbox"/> Celsius  | 7 <input type="checkbox"/> Fahrenheit |
| 4 <input type="checkbox"/> imperial |                                       |

- A a system of measurement based on meters and grams
- B a temperature system in which water boils at 212 degrees
- C a temperature system in which water freezes at zero degrees
- D a system of measurement based on feet and pounds
- E a unit equal to one sixteenth of a pound
- F a unit equal to one hundredth of a meter
- G a unit equal to one thousand grams



4 Read the sentence pairs. Choose which word best fits each blank.

1 inch / pound

- A The sandwich weighed almost a(n) \_\_\_\_\_.
- B The coin is about a(n) \_\_\_\_\_ inch in diameter.

2 gram / degree

- A The paperclip weighed about one \_\_\_\_\_.
- B The temperature cooled one \_\_\_\_\_ over ten minutes.

5 Listen and read the conversion chart again. How can someone convert grams into ounces?

## Listening

6 Listen to a conversation between two engineers. Choose the correct answers.

- 1 What is the conversation mostly about?
  - A why the woman prefers the metric system
  - B an error while making a measurement conversion
  - C the challenges of working with the imperial system
  - D the conversion rate for units of length
- 2 According to the woman, why should the man show measurements in both systems?
  - A It will make further conversions easier.
  - B Everyone will be able to read the measurements.
  - C Engineers tend to use both measurement systems.
  - D Other products include both types of measurements.

7 Listen again and complete the conversation.

- Engineer 1:** How should I list 1 \_\_\_\_\_ this hardware component?
- Engineer 2:** You should probably list them in both metric 2 \_\_\_\_\_ units.
- Engineer 1:** So, to be clear that's centimeters 3 \_\_\_\_\_, right?
- Engineer 2:** Yeah. That way, everyone will be able to read them.
- Engineer 1:** Good idea. Do you know the conversion rates? I always 4 \_\_\_\_\_.
- Engineer 2:** I think an inch 5 \_\_\_\_\_ 2.54 centimeters.
- Engineer 1:** Okay. This component is eight 6 \_\_\_\_\_ . Eight times 2.54 equals 20.32 centimeters.
- Engineer 2:** Yeah, that sounds about right.

## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*How should I ...?*

*So to be clear, that's ...*

*I think ...*

**Student A:** You are an engineer. Talk to Student B about:

- which system you should use to measure something
- how to convert measurements into the correct units

**Student B:** You are an engineer. Talk to Student A about conversion rates between measurement units.

## Writing

9 Use the conversation from Task 8 to fill out the conversion notes.

### Measurements of: Weight

There are \_\_\_\_\_ in a(n) \_\_\_\_\_.

Two \_\_\_\_\_ equals \_\_\_\_\_.

Measurements of: \_\_\_\_\_

There are \_\_\_\_\_ in a(n) \_\_\_\_\_.

Half of a(n) \_\_\_\_\_ equals \_\_\_\_\_.

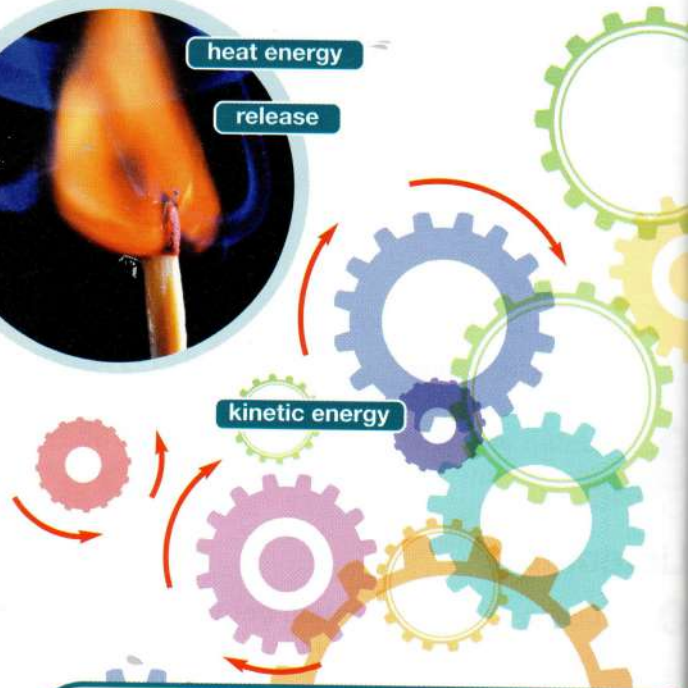
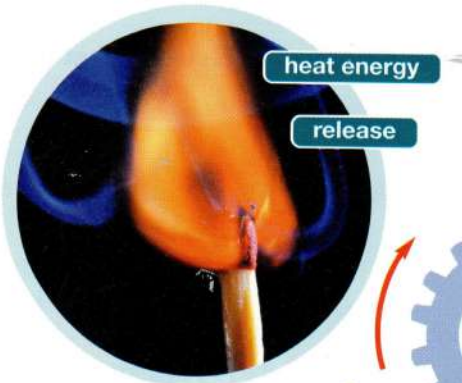
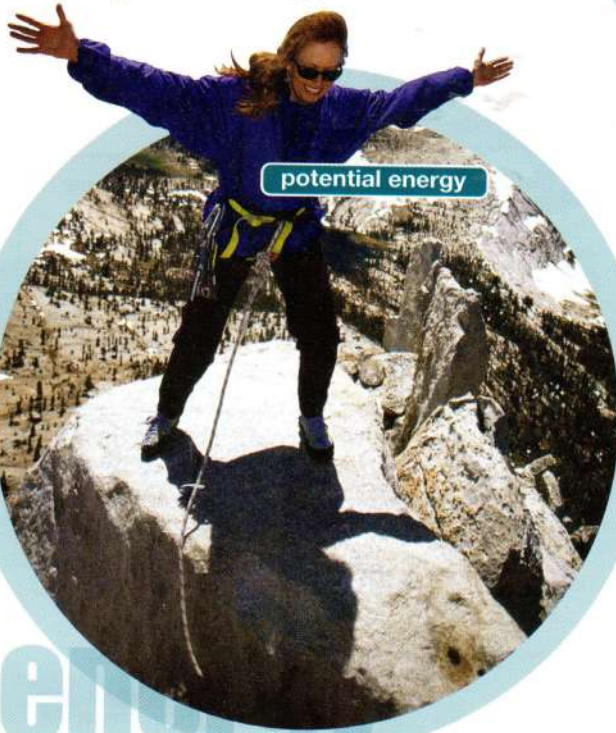


# 12 Energy

## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What are some different types of energy?
- 2 What happens when two surfaces rub against each other?



## energy

Chapter 12.1.1

All **energy** is either **kinetic energy** or **potential energy**. For instance, **chemical energy** is a form of potential energy. During a chemical reaction, a substance **releases** potential energy. When this happens, the energy becomes kinetic. The result of kinetic energy is often called **work**.

Energy cannot be destroyed. In physics, the law of **conservation of energy** states that the total amount of energy in a system remains constant over time. However, energy can change forms. Many processes **transfer** energy between objects. For example, substances rubbing together encounter **friction**. This prevents objects from sliding smoothly against each other. Friction prevents some potential energy from becoming kinetic. During friction, some of the energy is released as **heat energy**.

## Reading

2 Read the textbook chapter. Then, mark the following statements as true (T) or false (F).

- 1 \_\_\_ The two main types of energy are potential energy and chemical energy.
- 2 \_\_\_ Chemical reactions convert potential energy into kinetic energy.
- 3 \_\_\_ The laws of physics prevent the transfer of energy between objects.

## Vocabulary

3 Match the words or phrases (1-6) with the definitions (A-F).

- 1 \_\_\_ heat energy
- 2 \_\_\_ work
- 3 \_\_\_ conservation of energy
- 4 \_\_\_ kinetic energy
- 5 \_\_\_ potential energy
- 6 \_\_\_ chemical energy

- A action or movement produced by kinetic energy
- B energy expressed through activity or movement
- C to keep constant through physical or chemical reactions
- D energy that is released through a chemical reaction
- E energy which is stored, ready to be released
- F a form of energy that causes temperatures to rise



4 Read the sentence pairs. Choose which word best fits each blank.

1 friction / energy

- A According to the laws of physics, it is impossible to destroy \_\_\_\_\_.
- B Ice is slippery because it does not have much \_\_\_\_\_.

2 transfers / releases

- A An explosion usually \_\_\_\_\_ a large amount of energy into the surrounding area.
- B A stove \_\_\_\_\_ heat from the burner to the pot.

5 Listen and read the textbook chapter again. What are the energy transfers during friction?

## Listening

6 Listen to a conversation between an instructor and a student. Choose the correct answers.

- 1 What is the main idea of the conversation?
- A methods for conserving energy  
B how to classify a type of energy  
C ways to avoid releasing energy  
D which type of energy is most useful
- 2 What does the woman identify incorrectly?
- A friction  
B chemical energy  
C potential energy  
D heat energy

7 Listen again and complete the conversation.

**Instructor:** Are you ready for the test tomorrow?

**Student:** Yeah, I think so.

**Instructor:** Okay, then. What are the two basic 1 \_\_\_\_\_?

**Student:** Are they 2 \_\_\_\_\_ and kinetic energy?

**Instructor:** Correct. And which type of energy is 3 \_\_\_\_\_?

**Student:** Hmm. Chemical energy is a form of 4 \_\_\_\_\_, right?

**Instructor:** Nope. You've 5 \_\_\_\_\_. Chemical energy is actually a form of potential energy.

**Student:** Ah, that's right. Chemical energy becomes kinetic energy through 6 \_\_\_\_\_.

## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*What are the ...?*

*You've got that backwards.*

*That's right.*

**Student A:** You are an instructor. Talk to Student B about:

- the basic types of energy
- an error that he or she makes
- the characteristics of a particular type of energy

**Student B:** You are a student. Talk to Student A about types of energy.

## Writing

9 Use the conversation from Task 8 to fill out the student's notes.



## Notes on Energy

- The two basic types of energy are \_\_\_\_\_ and \_\_\_\_\_.
- \_\_\_\_\_ is a type of \_\_\_\_\_.
- \_\_\_\_\_ becomes \_\_\_\_\_ when \_\_\_\_\_.

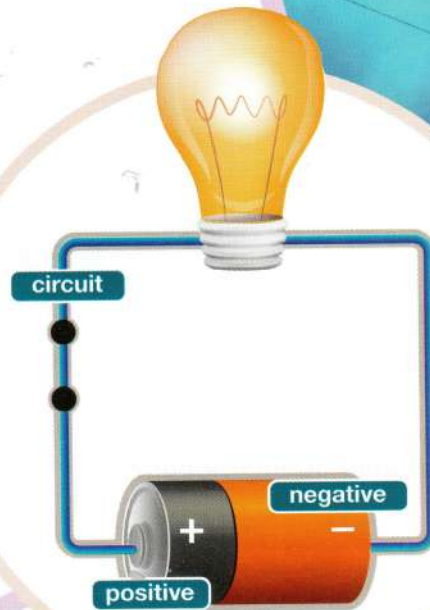
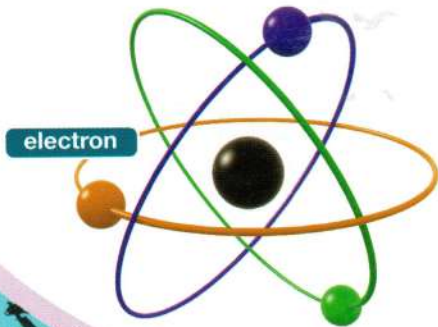


# 13 Electricity 1

## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What determines whether an object has a positive or negative charge?
- 2 What is the difference between a direct current and an alternating current?



## ENGR 120 INTRODUCTION TO electricity

Harnessing **electricity** is one of mankind's greatest achievements. ENGR 120 introduces the fundamentals of this fascinating natural force.

The course begins with the basics of electricity. It addresses how **electrons** and electron holes create **positive** and **negative charges**. Students will learn why some substances **conduct** electricity while others do not. They will also learn what determines a circuit's **polarity**.

Later in the semester, the course covers applications of electricity. The class will visit a power plant. There, they will learn about generating electricity. Students must also attend a workshop on everyday applications of electricity. The workshop includes practical experiments with **direct currents** and **alternating currents**.

## Reading

2 Read the course description. Then, mark the following statements as true (T) or false (F).

- 1  The course begins with practical uses of currents.
- 2  Students will go to a power plant later in the semester.
- 3  Students must attend a workshop on generating electricity.

## Vocabulary

3 Match the words or phrases (1-6) with the definitions (A-F).

- |                                     |  |
|-------------------------------------|--|
| 1 <input type="checkbox"/> conduct  | 4 <input type="checkbox"/> electricity         |
| 2 <input type="checkbox"/> positive | 5 <input type="checkbox"/> direct current      |
| 3 <input type="checkbox"/> negative | 6 <input type="checkbox"/> alternating current |

- A possessing a charge the same as that of an electron
- B possessing a charge opposite to that of an electron
- C to allow electricity to pass through something
- D a form of energy caused by charged particles
- E a charge that switches the direction of its flow constantly
- F a charge that flows in a single direction



4 Read the sentence pairs. Choose which word best fits each blank.

1 charge / circuit

- A A negative \_\_\_\_\_ has extra electrons.
- B If a \_\_\_\_\_ is broken, electricity cannot flow all the way through it.

2 electron / polarity

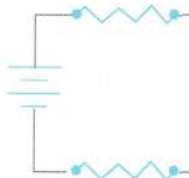
- A A(n) \_\_\_\_\_ is a very small particle.
- B The circuit's \_\_\_\_\_ changed from positive to negative.

5 Listen and read the course description again. How will the class learn about generating electricity?

### Listening

6 Listen to a conversation between two students. Choose the correct answers.

- 1 What is the conversation mostly about?
  - A a test question that the man missed
  - B what information is likely to be on a test
  - C a concept that the woman misunderstands
  - D which concepts will be covered in class
- 2 What is the man mistaken about?
  - A the types of electrical charges
  - B where electricity comes from
  - C the definition of an electron
  - D the difference between direct and alternating currents



7 Listen again and complete the conversation.

**Student 1:** Hey, do you know what 1 \_\_\_\_\_ tomorrow's electricity test?

**Student 2:** Well, it'll probably ask what 2 \_\_\_\_\_ is.

**Student 1:** Oh, I know that one. It's a subatomic particle with a 3 \_\_\_\_\_.

**Student 2:** Right. The test might ask about different charges, too.

**Student 1:** Charges are 4 \_\_\_\_\_, right?

**Student 2:** No. You're thinking of currents. A charge can be either 5 \_\_\_\_\_.

**Student 1:** Oh, that's right. And that depends on how many electrons it has.

**Student 2:** You've got it. 6 \_\_\_\_\_ you'll do fine on the test.

### Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

*Do you know ...? / Isn't that ...? / You're thinking of ...*

**Student A:** You are a student. Talk to Student B about:

- the information that will likely be on a test
- definitions of electrical terms
- a concept that you are not sure about

**Student B:** You are a student. Talk to Student A about the information that will likely be on a test.

### Writing

9 Use the conversation from Task 8 to fill out the student's notes.

## CHAPTER 7: ELECTRICITY

Notes:

- \_\_\_\_\_ can be either \_\_\_\_\_.  
This is determined by \_\_\_\_\_.
- The definition of a(n) \_\_\_\_\_ is \_\_\_\_\_.

Reminder: Study for the test next week. It will cover \_\_\_\_\_.



# 14 Electricity 2

## HANDY'S HOME GUIDES

### COMPUTERS

### Power Supply Units (PSU)



Before you purchase a power supply unit, you should understand its basic functions. A computer's PSU controls its supply of **electrical energy**. It works by managing the strength of electrical **currents**.

A PSU receives energy from a wall outlet. Then, it regulates the **electrical power** that travels through the circuit. The power is delivered to the computer at the appropriate **wattage**. Most computers require between 300 and 350 **watts**.

However, different computer components require different **voltages**. To find a component's voltage requirements, you need to know its **resistance**. Some components are better **conductors** than others. These components have fewer **ohms** of resistance. Many processors require 100 **amperes** of power at about two **volts**. Understand your system's specifications before you install a PSU.

## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What are some different units that are used to measure electrical currents?
- 2 What is the difference between electrical energy and electrical power?

## Reading

2 Read the guide. Then, choose the correct answers.

- 1 What is the main idea of the guide?
  - A how to improve a computer's performance
  - B how to choose the right part for a computer
  - C how to install replacement components
  - D how to know when to replace a computer
- 2 Which of the following is NOT determined by a PSU?
  - A a circuit's electrical power
  - B the voltage of a power supply
  - C a conductor's resistance
  - D the strength of a current
- 3 Why do different components require different voltages?
  - A they have different levels of resistance
  - B some of them do not conduct electricity
  - C they use electrical energy differently
  - D some have independent power sources

## Vocabulary

3 Match the words (1-6) with the definitions (A-F).

- |               |                  |
|---------------|------------------|
| 1 ___ ohm     | 4 ___ current    |
| 2 ___ watt    | 5 ___ conductor  |
| 3 ___ voltage | 6 ___ resistance |

- A a unit that measures electrical power
- B a material that transmits electricity
- C the amount of power in an electrical current
- D a flow of electricity caused by the movement of charged particles
- E a unit that measures an object's resistance
- F the ability to obstruct the flow of electricity



4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 electrical energy / electrical power

A Some computer components manipulate a circuit's \_\_\_\_\_.

B The movement of electrons generates \_\_\_\_\_.

2 ampere / volt

A A(n) \_\_\_\_\_ measures an electrical current's flow.

B A(n) \_\_\_\_\_ measures the electrical power of a current.

5 Listen and read the guide again. What are the power requirements of most processors?

## Listening

6 Listen to a conversation between an engineer and a homeowner. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The man connected the power supply incorrectly.
- 2 \_\_\_ The man's PSU cannot handle the resistance of the computer components.
- 3 \_\_\_ The woman recommends replacing most of the computer components.

7 Listen again and complete the conversation.

**Engineer:** No, your wiring was fine. But it looks like you  
1 \_\_\_\_\_ an older PSU.

**Homeowner:** That's right. I got one from a friend.

**Engineer:** Well, your computer requires a higher wattage. This PSU isn't 2 \_\_\_\_\_.

**Homeowner:** Why 3 \_\_\_\_\_ need to be higher?

**Engineer:** You have a number of extra cables and components. That 4 \_\_\_\_\_ on the current.

**Homeowner:** Oh, I see. Can 5 \_\_\_\_\_ a better PSU?

**Engineer:** Certainly. Give me 6 \_\_\_\_\_ to check all the specifications.



## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*I found the problem ...*

*Did I ... incorrectly?*

*You need to have something that ...*

**Student A:** You are an engineer. Talk to Student B about:

- a problem with his or her computer
- the cause of the problem
- how to fix the problem

**Student B:** You are a homeowner. Talk to Student A about a problem with your computer.

## Writing

9 Use the conversation from Task 8 to fill out the engineer's receipt for services.

### Receipt for Services

Customer: \_\_\_\_\_

Malfunction: \_\_\_\_\_

Cause of malfunction: \_\_\_\_\_

Actions taken: \_\_\_\_\_

Recommendations: \_\_\_\_\_



# 15 Education

## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What classes do students usually take as part of a computer engineering degree?
- 2 What are some common prerequisites for computer engineering programs?

## Central University – Bachelor's of Science in Computer Engineering

[www.central-university.edu/programs/degrees/computerengineering.html](http://www.central-university.edu/programs/degrees/computerengineering.html)



## Reading

2 Read the webpage. Then, mark the following statements as true (T) or false (F).

- 1  Students study mathematics before they are admitted to the program.
- 2  The first semester includes a course in signal processing.
- 3  Students are required to take calculus courses during the first year of the program.

## Vocabulary

3 Match the words (1-6) with the definitions (A-F).

- |  |   |
|--|---|
| 1 <input type="checkbox"/> foundation        | 4 <input type="checkbox"/> signal processing      |
| 2 <input type="checkbox"/> mathematics       | 5 <input type="checkbox"/> electrical engineering |
| 3 <input type="checkbox"/> bachelor's degree | 6 <input type="checkbox"/> computer architecture  |

- A a certificate that is earned after four years of study
- B a class that students take to prepare for a degree program
- C the process of creating computers from hardware components
- D a general field of study concerned with numbers and shapes
- E a branch of engineering that focuses on the uses of electricity
- F a branch of engineering that studies communication between electrical components and devices



Central University offers a **bachelor's degree** in computer engineering. The program covers circuitry and other aspects of **electrical engineering**. It also includes a comprehensive education in computer science. Students will gain an advanced understanding of computer hardware and software.

The first semester includes courses in **computer architecture**. These teach the basic physical structure of computers. Then, students move on to **programming**. This is where they will learn how to create software. Later courses include **signal processing** and **hardware design**.

Program applicants must have a strong background in **mathematics** and science. Before officially entering the program, students must take several **foundation** courses. These include introductory courses in **physics** and **calculus**.



4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 calculus / physics

- A The lecture on \_\_\_\_\_ explains how gravity works.  
B The student used \_\_\_\_\_ to find the slope of the curve.

2 programming / hardware design

- A The student's skill at \_\_\_\_\_ helped her rewrite the software.  
B The man created a new processor in his \_\_\_\_\_ class.

5 Listen and read the webpage again. What courses must students take before applying to the computer engineering program?

## Listening

6 Listen to a conversation between an academic advisor and a student. Choose the correct answers.

- 1 What is the conversation mostly about?  
A the woman's grades in the previous semester's courses  
B the woman's application to enter the computer engineering program  
C the woman's progress towards a bachelor's degree  
D the woman's concerns about completing her engineering courses
- 2 Which of the following courses did the woman already take?  
A programming                      C hardware design  
B electrical engineering          D signal processing

7 Listen again and complete the conversation.

**Advisor:** So, Lisa. You wanted to discuss 1 \_\_\_\_\_ towards your degree?  
**Student:** Yes. I'd also like to plan my next 2 \_\_\_\_\_.  
**Advisor:** Let's see. You're about 3 \_\_\_\_\_ the bachelor's degree program.  
**Student:** That sounds about right. I just finished classes in programming and 4 \_\_\_\_\_.  
**Advisor:** Good. It looks like your ready for advanced 5 \_\_\_\_\_.  
**Student:** What does that include?  
**Advisor:** Well, I'd recommend enrolling in 6 \_\_\_\_\_ and hardware design.  
**Student:** Okay. I'll sign up for both next semester.

## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*You're about halfway ...*  
*I just finished ...*  
*I thought I'd ...*

**Student A:** You are an academic advisor. Talk to Student B about:

- his or her progress towards a degree
- the classes the student has already taken
- the classes the student still needs to take

**Student B:** You are a student. Talk to Student A about your progress towards a degree.

## Writing

9 Use the conversation from Task 8 to fill out the degree progress report.

### Mid-Year Progress Report

Advisor: \_\_\_\_\_

Student: \_\_\_\_\_

Before entering the program, the student completed \_\_\_\_\_

After entering the program, the student completed \_\_\_\_\_

Next, the student should \_\_\_\_\_



## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What does a programmer do?
- 2 How does translation affect computer function?

## Chapter 3

27

## How computers process information

Computers are constantly processing large amounts of information. Operating a computer involves sending and receiving complex sets of instructions. Computers have their own language, called **machine language**. Machine language is made up of **binary digits** that are represented by the numbers 0 and 1. Every possible computer operation is encoded with different combinations of these two numbers.

However, **programmers** usually do not send commands in machine language. They write software in **human-readable programming languages**. This allows programmers to write software quickly and efficiently. These languages, like **C** and **Java**, are more compatible with the way humans think. However, computers still require instructions in machine language.

**Systems software** facilitates this communication within the computer. A **compiler** is a software component that **translates** human-readable language into an **assembly language**. This language is simpler than a human-readable language. But it still uses letters and words. The computer needs an **assembler** to turn those instructions into the binary translation.

For example the programmer might write the command "A + B." Then, a compiler converts it into an assembly language: "Add A,B." Finally, an assembler translates it into machine language: "1000110010100000." The computer uses these instructions to perform the command.

## Reading

2 Read the textbook chapter. Then, choose the correct answers.

- 1 What is the main idea of the chapter?
  - A how to write a computer program
  - B recent changes in computer software
  - C how computers send and receive information
  - D a comparison of different programming theories
- 2 Which language does NOT need translation before a computer reads it?
 

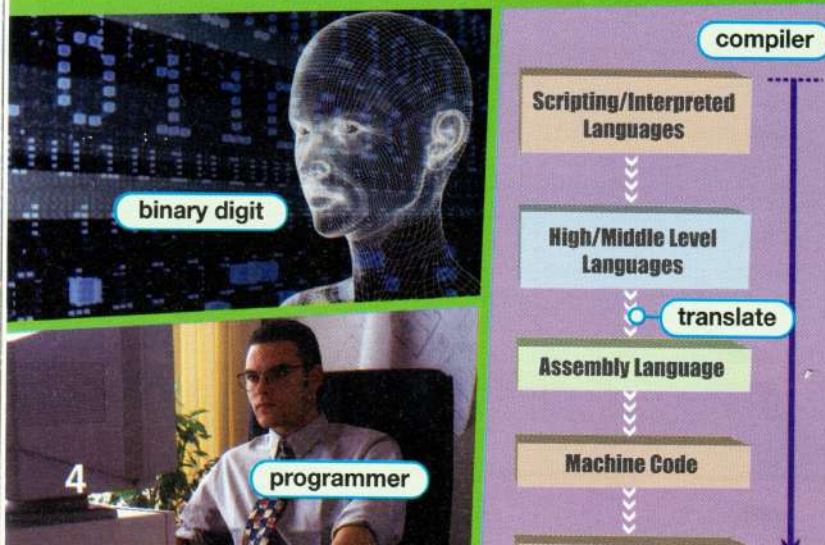
A assembly language	D human-readable programming language
B machine language	
C Java	
- 3 What is true of binary digits?
  - A They are also called assembly language.
  - B They are most commonly used by programmers to write instructions.
  - C They are not complex enough for most computer operations.
  - D They are used to encode all computer functions.

## Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |                        |                       |
|------------------------|-----------------------|
| 1 __ assembly language | 5 __ machine language |
| 2 __ Java              | 6 __ compiler         |
| 3 __ C                 | 7 __ assembler        |
| 4 __ programmer        | 8 __ translate        |

- A a program that converts complicated operations into simpler letters and words
- B a program that changes written instructions into a binary translation
- C a set of instructions written in numerical form
- D a human-readable programming language that is object-oriented and simple
- E to convert something from one form to another
- F written instructions that have not been converted to a binary translation
- G a person who writes and develops software
- H a human-readable programming language that is focused on procedures





**4** Write a word or phrase that is similar in meaning to the underlined part.

1 Computers can only understand commands written in a system that uses a combination of zeros and ones.

\_ i \_ \_ r \_ \_ d \_ g \_ \_ s

2 In order to write programs quickly and efficiently, we use words that are designed to send instructions to computers.

h \_ \_ a \_ \_ r \_ \_ \_ a b \_ \_ p \_ o \_ \_ \_ m m \_ \_ g  
\_ a n \_ u \_ g \_ s

3 Computers are built with a program that provides basic functions in order to facilitate operation.

s \_ \_ \_ e \_ s s \_ f \_ w \_ \_ e

**5** Listen and read the textbook chapter again. Why is human-readable programming language useful?

**Listening**

**6** Listen to a conversation between a student and an instructor. Mark the following statements as true (T) or false (F).

- 1  The man completed a Java assignment.
- 2  The woman recommends strategies for learning different languages.
- 3  According to the woman, having many languages helps engineers build faster computers.

**7** Listen again and complete the conversation.

**Student:** I'm having a hard time 1 \_\_\_\_\_ straight. There are so many.

**Instructor:** There are quite a few. Which ones are you having trouble with?

**Student:** All of them. I think it's 2 \_\_\_\_\_ all these languages.

**Instructor:** I see where you're coming from. It's a lot to learn.

**Student:** But why are there 3 \_\_\_\_\_ languages?

**Instructor:** The first reason is that it makes 4 \_\_\_\_\_.

**Student:** 5 \_\_\_\_\_ ?

**Instructor:** The computer only understands 6 \_\_\_\_\_, or binary digits. It would take programmers a long time to write programs in binary format.

**Speaking**

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

*I'm having a hard time understanding ...*

*There are quite a few ...*

*How does that help?*

**Student A:** You are a student. Talk to Student B about:

- the different kinds of programming languages
- why you are confused
- the uses of different languages

**Student B:** You are an instructor. Talk to Student A about the uses of different programming languages.

**Writing**

**9** Use the textbook chapter and the conversation from Task 8 to write a student's notes on programming languages. Include: at least two different programming languages, their functions, and their benefits.

```

MONITOR FOR 6802 1.4
9-14-80 TSC ASSEMBLER PAGE 2
C000
C000 8E 00 70 START ORG ROM+$0000 BEGIN MONITOR
#STACK
*****
* FUNCTION: INITA - Initialize ACIA
* INPUT: none
* OUTPUT: none
* CALLS: none
* DESTROYS: acc A
0013 RESETA EQU
0011 CTLREG EQU
assembly language
C003 86 13 INITA LDA A #RESETA RESET ACIA
C005 B7 80 04 STA A ACIA
C008 86 11 LDA A #CTLREG SET 8 BITS AND 2 STO
C00A B7 80 04 STA A ACIA
C00D 7E C0 F1 JMP SIGNON GO TO START OF MONIT
*****
* FUNCTION: INCH - Input character
* INPUT: none
* OUTPUT: char in acc A
* DESTROYS: acc A
* CALLS: none
* DESCRIPTION: Gets 1 character from termin
C010 B6 80 04 INCH LDA A ACIA GET STATUS
C013 47 ASR A SHIFT RDRF FLAG II
C014 24 FA BCC INCH RECIEVE NOT READY
LDA A ACIA+1 GET CHAR
MASK PARITY

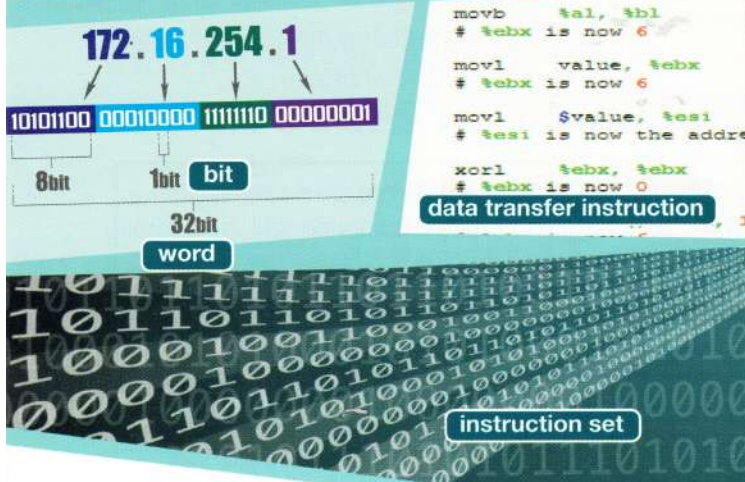
```



## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What determines a computer's actions?
- 2 How does a computer retrieve information from its memory?



## How computers Process Information

A computer's function is to follow specific commands, or **instruction sets**. However, processing multiple commands can be time-consuming. The **stored-program concept** allows **instructions** to be efficiently stored in machine language.

Storing instructions in the machine's **register** allows information to be accessed more quickly. Registers are made of **bits**, or binary digits. Since bits are so small, they are typically used in groups. A **word** is the most commonly used grouping of bits. It is often made up of 32 or 64 bits, depending on the system. The speed at which **data** is accessed depends upon the available number of bits.

Information stored in the long-term memory of the computer must also be available. A **data transfer instruction** allows data to transfer from the memory to the registers. Then it becomes easily accessible and can be retrieved more quickly. The data must have a destination, or **address**, that is also sent by the data transfer instruction.

When data is put into the computer, various instructions are executed. A **basic block** is the most fundamental set of instructions. More complex sets include **conditional branches**. Unlike basic blocks, these can only execute after previous instructions are complete.

## Reading

2 Read the textbook chapter. Then, choose the correct answers.

- 1 What is the main idea of the article?
  - A the history of computer languages
  - B how a computer stores and transfers data for use
  - C the benefits of different programming languages
  - D a comparison of typical instructions that computers must execute
- 2 What is true about a computer's registers?
  - A They are a type of long term memory.
  - B They are the only devices on a computer that store data.
  - C They are used for temporary storage.
  - D They are not necessary for computer operation.
- 3 What can you infer about basic blocks?
  - A They do not depend on the completion of previous instructions.
  - B They are not as important as conditional branches.
  - C They are rarely used.
  - D They are the fastest type of instruction.

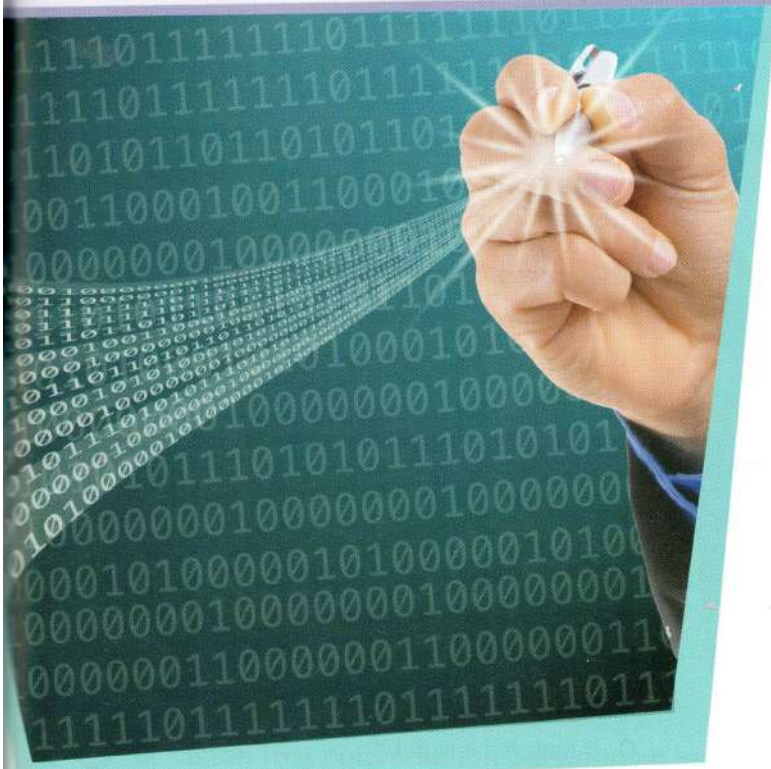
## Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |                                |                  |
|--------------------------------|------------------|
| 1 __ stored-program concept    | 5 __ bit         |
| 2 __ basic block               | 6 __ register    |
| 3 __ data transfer instruction | 7 __ word        |
| 4 __ conditional branch        | 8 __ instruction |

- A a series of instructions that does not have branches
- B a command that is part of a computer language
- C an action that is only completed if other actions are completed first
- D the theory that instructions can be stored as numbers in the computer's memory
- E a part of the computer's hardware that temporarily stores instructions
- F an operation on a computer that moves data from one type of storage to another
- G a standard group of units of information
- H the smallest unit of information on a computer





**4** Read the sentence pairs. Choose which word or phrase best fits each blank.

**1 instruction set / word**

- A A(n) \_\_\_\_\_ is a series of commands.
- B A(n) \_\_\_\_\_ can be part of a command.

**2 data / address**

- A The information is transferred to a particular \_\_\_\_\_.
- B \_\_\_\_\_ from the long term memory goes to a register for temporary use.

**5** Listen and read the textbook chapter again. What is the importance of a data transfer instruction?

**Listening**

**6** Listen to a conversation between an instructor and a student. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The speakers discuss the woman's score on an exam.
- 2 \_\_\_ According to the woman, instructions help to control the computer's hardware.
- 3 \_\_\_ The man identifies stored-program concept incorrectly.

**7** Listen again and complete the conversation.

**Instructor:** All right. Tell me what you know about instructions.

**Student:** Those are the computer's language. 1 \_\_\_\_\_ to the computer in order to control its hardware.

**Instructor:** Good. Next question. Why is the 2 \_\_\_\_\_ - \_\_\_\_\_ ?

**Student:** It's the idea that 3 \_\_\_\_\_ in the computer's memory.

**Instructor:** Why is that necessary?

**Student:** It makes 4 \_\_\_\_\_, right?

**Instructor:** Correct. And how does the machine retrieve data 5 \_\_\_\_\_ ?

**Student:** Let's see. That requires a data transfer instruction. Then data moves 6 \_\_\_\_\_ to the registers.

**Speaking**

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

*Don't forget to ... / I'll remember ...*  
*Please explain ...*

**Student A:** You are an instructor. Talk to Student B about:

- the quiz on computer languages
- the definitions of important terms

**Student B:** You are a student. Talk to Student A about computer languages.

**Writing**

**9** Use the textbook chapter and the conversation from Task 8 to write an exam answer about computer languages. Include: the importance of instructions, how data is stored, and how data is transferred.



## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What is the function of arithmetic in computer processes?
- 2 Why should programmers know both programming and machine languages?

## Arithmetic in Computers

 $2_{10}$ 

subscript

least significant bit

1 0 1 0 1 1 0 0

MSB

most significant bit

LSB

8bit

+128

signed number

-16

Bits determine the fundamental functions of computers. Each word contains a set number of bits, and each combination corresponds to a number. These numbers are represented in one of several **number bases**. Although we typically think in **base 10**, computers function best in **base 2**. Each number set is **subscripted** with a ten or a two to indicate to whether it is decimal or binary.

Computers use arithmetic to signal various functions. Computers must distinguish between positive and negative numbers in order to operate the hardware. A **signed number** refers to a number that has a negative or positive sign. An **unsigned number** does not have a sign, so it must be zero or a positive number. **Two's complement** is a representation of signed binary numbers that uses **leading 0's** and **leading 1's**. If the word has a leading 0, it is positive. If it has a leading 1, it is negative.

The hardware is programmed to test the **sign bit** for positivity or negativity. The sign bit is also the **most significant bit**, which is farthest to the left. The bit with the highest value is the digit to the right of the sign bit. The rightmost bit is the **least significant bit**, or the bit with the lowest value.

base 10

 $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$ 
 $\{0, 1\}$ 

base 2

## Reading

2 Read the textbook chapter. Then, choose the correct answers.

- 1 What is the main idea of the article?
  - A benefits of different number systems
  - B the way numbers are represented in programming
  - C how to translate information between number systems
  - D practical applications for computer arithmetic
- 2 Which of the following is NOT true of the two's complement representation?
  - A It uses binary numbers.
  - B It can contain a leading 0.
  - C It features a sign bit.
  - D It occurs in base 10.
- 3 What tells a computer whether a number is positive or negative?
  - A sign bit
  - B number base
  - C least significant bit
  - D subscript

## Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |   |                  |   |                 |
|---|------------------|---|-----------------|
| 1 | two's complement | 5 | base 10         |
| 2 | sign bit         | 6 | signed number   |
| 3 | base 2           | 7 | subscript       |
| 4 | number base      | 8 | unsigned number |

- A the leading digit that is tested by the hardware to indicate whether a number is positive or negative
- B the representation of binary numbers using leading 0 and leading 1
- C a number that does not have a negative or a positive sign
- D to add a distinguishing number or character to a larger number or character
- E the indication of how many numbers are used in a certain system
- F a number system, also called the decimal system, that uses the numbers 1 through 10
- G a number that is either positive or negative
- H a number system, also called the binary system, that uses the numbers 0 and 1



4 Read the sentence pairs. Choose which phrase best fits each blank.

1 leading 0 / leading 1

- A Since this word has a \_\_\_\_\_, it is negative.
- B On the other hand, a \_\_\_\_\_ indicates that the number is positive.

2 most significant bit / least significant bit

- A The \_\_\_\_\_ is also known as the sign bit.
- B The bit farthest to the right is the \_\_\_\_\_.

5 Listen and read the textbook chapter again. What is the difference between base 10 and base 2?

## Listening

6 Listen to a conversation between an instructor and a student. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The woman identifies the number bases incorrectly.
- 2 \_\_\_ According to the man, positive and negative numbers can be difficult to identify.
- 3 \_\_\_ According to the man, two's complement is a better system than signed numbers.

7 Listen again and complete the conversation.

**Student:** I don't have a good grasp of how 1 \_\_\_\_\_ can be represented.

**Instructor:** There are several ways that they can be identified.

**Student:** I'm just 2 \_\_\_\_\_ about it.

**Instructor:** As you know, there are 3 \_\_\_\_\_ numbers.

**Student:** Isn't there a problem with using signs to 4 \_\_\_\_\_ ?

**Instructor:** Yes, there is. That's why we use the two's complement representation.

**Student:** Can you 5 \_\_\_\_\_ ?

**Instructor:** Basically, it is a way of 6 \_\_\_\_\_ as binary digits. It uses leading 0s and leading 1s to indicate whether it is positive or negative.

## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*I'm confused about ...*

*There are several ...*

*Can you clarify that for me?*

**Student A:** You are a student. Talk to Student B about:

- computer arithmetic
- what you need explained
- how numbers are represented

**Student B:** You are an instructor. Talk to Student A about how numbers are represented.

## Writing

9 Use the textbook chapter and the conversation from Task 8 to write a student's notes on computer arithmetic. Include: at least two different ways of identifying numbers, how they function, and which is more commonly used.

1 2 3 4 5 6 7 8 9 10

256  
128  
64328



## Arithmetic in Computers: Part II

$$\underline{2} + \underline{2} = 4$$

operand

$$2 + 3 = 5$$

addition

## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What are some common mathematical operations?
- 2 How is math used by computers?

## Reading

2 Read the textbook chapter. Then, choose the correct answers.

- 1 What is the main idea of the article?
  - A instructions for completing mathematical operations
  - B a comparison of different mathematical operations
  - C how computers execute mathematical operations
  - D sample equations for different mathematical operations
- 2 Which of the following is NOT a possible result of overflow?
  - A An exception occurs.
  - B Hardware is damaged.
  - C The program ignores it.
  - D The occurrence is recognized.
- 3 What is true of bit-wise shifts?
  - A They help reduce overflow.
  - B They improve the efficiency of multiplication.
  - C They are used in subtraction.
  - D They are operations that add extra bits.

Computers perform arithmetic that is similar to the operations that we perform by hand. **Addition** is a basic operation. The sum of two **operands** is used to execute a specific instruction. In computing, addition is also used to perform **subtraction**. In common subtraction, sometimes a **value** from the next higher digit must be **borrowed**. This ensures that the **result** is a positive value. However, computer arithmetic simply adds a negative value to a positive value for the same result.

Many calculations require **carry-outs**. This number is taken from the right column to the left in order to complete an operation. **Multiplication** and **division** are related operations that computers perform to complete instructions. A **bit-wise shift** helps computers complete these operations more quickly.

Occasionally, a calculation will produce **overflow**. Overflow occurs when an operation produces more digits than the hardware can handle. Some computer programs **ignore** overflow, while others must **recognize** it. When overflow is detected, an **exception** or **interrupt** occurs. This suspends the current program until the issue is resolved. If programmed correctly, the computer jumps to a predetermined address to handle the exception. It can then resume its normal operations.

## Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |                     |                |
|---------------------|----------------|
| 1 __ overflow       | 5 __ carry-out |
| 2 __ bit-wise shift | 6 __ value     |
| 3 __ exception      | 7 __ operand   |
| 4 __ recognize      | 8 __ borrow    |

- A an event that disrupts the execution of a program.
- B a number that is used in a mathematical equation
- C a condition that occurs when the result of a calculation is too large for the storage system of the computer
- D to notice something
- E to take a number, usually 10, from the next higher digit column
- F a number, either positive or negative
- G a number that is carried from the right column to the left in an equation
- H an operation that moves the value of bits left or right



$$2 \times 3 = 6$$

multiplication

$$3 - 2 = 1$$

subtraction

$$6 \div 2 = 3$$

division

4 Read the sentence pairs. Choose which word best fits each blank.

1 addition / subtraction

- A The process of \_\_\_\_\_ involves deducting one amount from another.
- B The computer uses \_\_\_\_\_ to combine sums.

2 multiplication / division

- A "Two times seven equals fourteen" is an example of \_\_\_\_\_.
- B \_\_\_\_\_ is used to find out how many times two goes into four.

3 result / interrupt

- A A(n) \_\_\_\_\_ is a temporary pause in the program.
- B We see the \_\_\_\_\_ when all operations are complete.

5 Listen and read the textbook chapter again. What does an exception do?

## Listening

6 Listen to a conversation between two students. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The man identifies an error in the math.
- 2 \_\_\_ The program will require minor adjustment.
- 3 \_\_\_ The students find an interrupt in the program.

7 Listen again and complete the conversation.

Student 1: Hey, Annie. Did you have a chance to look 1 \_\_\_\_\_ ?

Student 2: I was actually 2 \_\_\_\_\_. I could use some help.

Student 1: Great. I'll give you a hand.

Student 2: In looking it over, I 3 \_\_\_\_\_.

Student 1: What 4 \_\_\_\_\_ ?

Student 2: There must be an error in the math somewhere. The computer isn't able to 5 \_\_\_\_\_.

Student 1: Well, the math looks good. I don't 6 \_\_\_\_\_.

## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*Did you have a chance ...?*

*I noticed ...*

*I see what happened ...*

**Student A:** You are a student. Talk to Student B about:

- a new computer program
- problems you noticed
- possible solutions

**Student B:** You are a student. Talk to Student A about problems with a new program.

## Writing

9 Use the textbook chapter and the conversation from Task 8 to write a student's review of a new computer program. Include: what arithmetic was used, an identification of the problem, and a possible cause of the problem.



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3.678459  $\xrightarrow{\text{round}}$  3.68

6,720,000  $\xrightarrow{\text{scientific notation}}$   $672 \times 10^4$

$672 \times 10^4$   $\xrightarrow{\text{normalized}}$   $6.72 \times 10^6$

## Get ready!

1 Before you read the passage, talk about these questions.

- Why do computer engineers use floating point arithmetic?
- What extra bits are used to make approximations more accurate?

## Reading

2 Read the webpage. Then, choose the correct answers.

- Why do engineers use approximations in computer arithmetic?
  - Computers are not able to process infinite numbers.
  - Single precision words are too small for some exponents.
  - Double precision cannot completely eliminate underflow and overflow.
  - Numbers must be accurate within one-half ULP.
- What is the purpose of a sticky bit?
  - to avoid underflow and overflow
  - to implement more accurate rounding
  - to join double precision words
  - to round numbers to the nearest integer
- Which is NOT mentioned in the passage?
  - Scientific notation has a significand and an exponent.
  - Some tools increase accuracy in rounding.
  - Floating point makes it easy to express large numbers.
  - Approximations are usually not accurate.

## Answers to Tech Industry Questions

**Q:** What is floating point notation?

**A:** Floating point notation is closely related to the concept of **scientific notation**. It is a way of expressing very large or very small numbers. With floating point notation, we can express large numbers in 32-bit words.

Like scientific notation, **normalized** floating point notation has a **significant** and an **exponent**. In scientific notation, the standard format is  $a \times 10^b$ . The significand  $a$  can be an **integer** or any real number. Since floating point notation is used with the binary system, the format is  $a \times 2^b$ .

We use floating point because computers cannot calculate **infinite** numbers. The closest we can get is an **approximation**. There are a number of tools available to help make these approximations **accurate**.

In some cases, the exponent is too large for a **single precision** word. **Double precision** minimizes occurrences of overflow and **underflow**. There are also a number of rounding tools that are commonly used. **Guard digits** allow for greater accuracy during intermediate addition. In some situations, a **sticky bit** is added before the number is finalized. The sticky bit ensures that numbers are **rounded** accurately. In ideal circumstances, the numbers are accurate within one-half **ULP**.

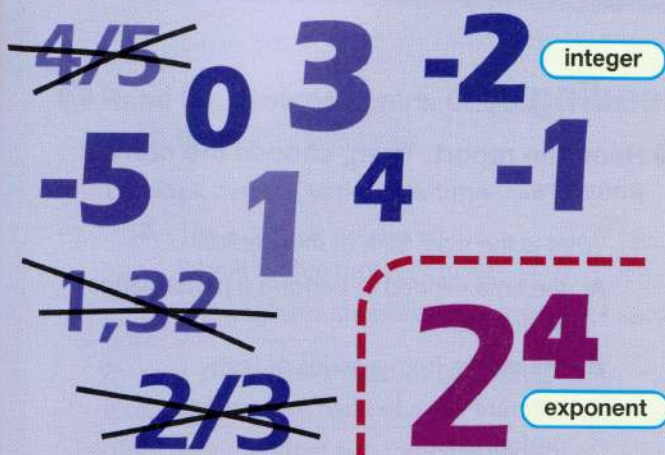
## Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |               |                       |
|---------------|-----------------------|
| 1 __ ULP      | 5 __ underflow        |
| 2 __ guard    | 6 __ floating point   |
| 3 __ integer  | 7 __ single precision |
| 4 __ exponent | 8 __ double precision |

- a natural number, the negative of a natural number, or zero
- a number that indicates to what power another number is raised
- a situation in which a negative exponent is too large for a 32-bit word
- the expression of a value in a 32-bit word
- the expression of a value in two 32-bit words
- a type of computer arithmetic using a moveable binary point
- a measure of the margin of error in rounding
- an extra bit added to the right of the binary point





4 Fill in the blanks with the correct words or phrases from the word bank.

**Word BANK**

round infinite sticky bit accurate  
scientific notation normalized approximation

- The numbers we provided were only a rough \_\_\_\_\_.
- A(n) \_\_\_\_\_ is sometimes added to make rounding more accurate.
- In \_\_\_\_\_ numbers, there are no leading zeroes.
- \_\_\_\_\_ is a convenient way of writing very large and very small numbers.
- The engineer decided to \_\_\_\_\_ up to the nearest dollar on the project budget.
- The error was caused by a calculation that was not \_\_\_\_\_.
- Computers cannot compute or store \_\_\_\_\_ values.

5 Listen and read the webpage again. How can engineers avoid situations in which the exponent is too large for a single precision word?

**Listening**

6 Listen to a conversation between an instructor and a student. Mark the following statements as true (T) or false (F).

- \_\_\_ The woman asks the man to explain scientific notation to the class.
- \_\_\_ The man confuses underflow and overflow.
- \_\_\_ The man got a high score on the floating point exam.

7 Listen again and complete the conversation.

**Instructor:** Todd, can you tell the class why we use 1 \_\_\_\_\_ arithmetic?  
**Student:** We use it so large numbers will fit in a 32-bit word.  
**Instructor:** That's right. How about an 2 \_\_\_\_\_ that's too large for the exponent field? Do you remember what that's called?  
**Student:** It's called 3 \_\_\_\_\_.  
**Instructor:** Close, but not quite. It's called 4 \_\_\_\_\_.  
**Student:** That's right, I always get those 5 \_\_\_\_\_ . Underflow is when a negative exponent is too large.  
**Instructor:** Correct. And what can we do to avoid overflow and underflow?  
**Student:** Well, sometimes we can use 6 \_\_\_\_\_ .

**Speaking**

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

Can you tell us ...? / That's right.  
Close, but not quite ...

**Student A:** You are an instructor. Talk to Student B about:

- floating point concepts
- what he or she knows about the subject
- what concepts will be on an upcoming exam

**Student B:** You are a student. Talk to Student A about floating point concepts.

**Writing**

9 Use the webpage and the conversation from Task 8 to write an essay on floating point concepts. Include: why computers use floating point arithmetic, how to ensure accurate calculations, and why computers use approximations instead of precise values.



## Get ready!

- 1 Before you read the passage, talk about these questions.
- 1 What are some ways to measure computer performance?
  - 2 Why are computer performance tests important?

## AJC Computers

## Computer Performance Report

**Client:** LewsTech industries

**Report Date:** 8/24

**Report Time:** 1:17 pm

On Friday, we ran several routine tests on the central office computer. Since the last evaluation, a few users complained about slow processing speeds. We used a variety of **metrics** to measure system **performance**. This included several types of time measurements. The goal of the tests was to assess the system's **execution time** and **throughput**. Most metrics were normal, but we will need to perform a few more tests.

We first tested the central processing units for each computer. This involved both the **wall-clock time** and the total **CPU time**. Each CPU was functioning at an expected level. We also evaluated the processors' ability to run programs with minimal resources. Both **user CPU time** and **system CPU time** were tested. According to the results, all programs are running smoothly.

We also looked at the processor itself. We examined the speeds of the **clock cycles**. We found that the **clock rate** is slower than normal. Each cycle was measured to determine overall **CPI**, or clock cycles per instruction. Based on our results, the IT team will further investigate the cause of the decreased processing speed.

## Reading

- 2 Read the report. Then, choose the correct answers.
- 1 What is the main idea of the article?
    - A the time needed to perform a performance evaluation
    - B the results from a series of tests
    - C different ways to improve computer performance
    - D a comparison of different testing methods
  - 2 Which is NOT true of clock cycles?
    - A They measure the speed of a processor.
    - B They have different lengths.
    - C They are used to determine CPI.
    - D They increase program efficiency.
  - 3 How will the IT team address the system issues?
    - A overhaul the system
    - B uninstall several programs
    - C install new processors
    - D investigate the problems further

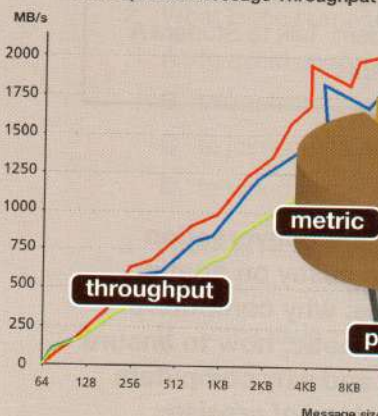
## Vocabulary

- 3 Match the words or phrases (1-7) with the definitions (A-G).

- |                     |                 |
|---------------------|-----------------|
| 1 __ performance    | 5 __ CPU time   |
| 2 __ CPI            | 6 __ metric     |
| 3 __ execution time | 7 __ throughput |
| 4 __ clock rate     |                 |

- A a measurement of a certain aspect of something's performance
- B the amount of work that something can do and the time it takes to accomplish it
- C the amount of work a computer can do in a specific amount of time
- D the number of clock cycles it takes to complete an instruction
- E the amount of time the central processing unit takes to complete a task
- F the rate of cycles per second a computer takes to perform
- G the time that elapses from the start of a task to the end

BMI Expected Message Throughput





4 Read the sentence pairs. Choose which phrase best fits each blank.

1 clock cycle / wall-clock time

A The engineer measured the \_\_\_\_\_ it took for the program to run.

B The engineer measured the duration of each \_\_\_\_\_.

2 user CPU time / system CPU time

A \_\_\_\_\_ runs the background structure that supports a program.

B The performance of the processor, while running programs, is measured by \_\_\_\_\_.

5 Listen and read the report again. How is the speed of a processor measured?

## Listening

6 Listen to a conversation between two engineers. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The test results showed strong CPI performance.
- 2 \_\_\_ The users of the computers complained about slow performance.
- 3 \_\_\_ According to the woman, the computer's throughput level was disappointing.

7 Listen again and complete the conversation.

**Engineer 2:** A few people complained that their computers were slow. So I used 1 \_\_\_\_\_ both the speed and capacity of the processor.

**Engineer 1:** What metrics did you use?

**Engineer 2:** I started with the central processing unit. I tested it for 2 \_\_\_\_\_.

**Engineer 1:** Good thinking. What did you find?

**Engineer 2:** Well, there's 3 \_\_\_\_\_.

**Engineer 1:** What's the good news?

**Engineer 2:** The throughput is still fairly high. The computer still processes large amounts of information in a 4 \_\_\_\_\_.

**Engineer 1:** Well, that is good. We need the computers to 5 \_\_\_\_\_.

**Engineer 2:** However, there were some 6 \_\_\_\_\_.

## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*Did you get ...?*

*There is good news ...*

*However, there is also ...*

**Student A:** You are an engineer. Talk to Student B about:

- a test that he or she just ran
- what metrics were used
- the results of the test

**Student B:** You are an engineer. Talk to Student A about a computer performance test.

## Writing

9 Use the report and the conversation from Task 8 to write a computer performance report. Include: two metrics that were tested, the results of the test, and further recommendations.







## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What are some ways to evaluate the performance of a computer?
- 2 How is arithmetic used to evaluate computer performance?

## Reading

2 Read the webpage. Then, choose the correct answers.

- 1 What is the main idea of the webpage?
  - A which manufacturers' machines have the best performance
  - B ways to improve a machine's performance
  - C a company's methods for evaluating a computer's performance
  - D how consumers can test computer performance at home
- 2 Which of the following is part of Amdahl's law?
  - A high percentages of program use
  - B a measure of the CPU
  - C decreasing performance over time
  - D changing one aspect to improve overall performance
- 3 How does the company assist its customers?
  - A testing manufacturers' statements
  - B increasing processing speed
  - C creating processing benchmarks
  - D comparing different weighting factors

## Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |                       |                               |
|-----------------------|-------------------------------|
| 1 __ workload         | 5 __ SPEC CPU benchmark       |
| 2 __ MIPS             | 6 __ SPEC ratio               |
| 3 __ reproducibility  | 7 __ arithmetic mean          |
| 4 __ weighting factor | 8 __ weighted arithmetic mean |

- A the ability to duplicate something
- B the average of execution times compared with total execution time
- C the percentage of usage that a program in a workload has
- D a measurement of the execution speed of a program by the millions of instructions
- E the sum of the weighting factors and execution times
- F the measurement of the execution time of a computer compared to that of another
- G a set of real programs that measure the performance of the central processing unit
- H the set of programs that a computer runs on a daily basis



## All About Computers: Performance Assessments

Manufacturers like to talk about the **workload** their computers can handle. But those claims aren't always reliable. At All About Computers, we assess computer systems and evaluate manufacturers' claims. We use a variety of **benchmarks** to measure computer performance. We use real **applications** that you use every day and measure their performance in **MIPS**. We follow the **reproducibility** rule. We also use **SPEC CPU benchmarks** and the **SPEC ratio**. This is how we test the execution times of the machine's central processing unit. We take steps to ensure the best, most reliable results.

### Our Process

Performance assessments require many calculations. The first is **arithmetic mean**. This compares the average execution time to the overall execution time. We also evaluate **weighting factors**. Programs with higher percentages of use have higher weighting factors. The weighting factor and execution times are used to calculate the **weighted arithmetic mean**. That yields the total performance of the workload.

### Why We Do It

Some manufacturers claim that a new version of a product is significantly faster. And they'll increase the price. But there's a limit to how much faster a system can get. (See our explanation **diminishing returns**.) **Amdahl's law** is also used to find the maximum expected improvement to a system when only part of it is improved. That's why bringing in All About Computers is worth the investment.



4 Read the sentence pairs. Choose which word or phrase best fits each blank.

1 benchmarks / applications

- A \_\_\_\_\_ are the programs that a computer executes every day.  
B One way to evaluate computer performance is to use \_\_\_\_\_.

2 Amdahl's law / diminishing returns

- A According to \_\_\_\_\_, adjusting one element of a computer can help to find the maximum expected improvement to a whole system.  
B According to \_\_\_\_\_, increasing a production element can decrease production in the long run.

5 Listen and read the webpage again. What is the function of benchmarks?

## Listening

6 Listen to a conversation between an engineer and an intern. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The woman made an error when she tested the computer speed.  
2 \_\_\_ The manufacturer made illegal claims about the new computers.  
3 \_\_\_ The weighted arithmetic mean shows a small difference in speed.

7 Listen again and complete the conversation.

- Engineer:** Let's 1 \_\_\_\_\_. I think you'll be surprised.  
**Intern:** Really? Why is that?  
**Engineer:** Well, this manufacturer 2 \_\_\_\_\_ were fifteen percent faster, right?  
**Intern:** Right. Is that not true?  
**Engineer:** Not according to our tests. It failed to meet 3 \_\_\_\_\_.  
**Intern:** So they lied about their product? Isn't that illegal?  
**Engineer:** They didn't lie, exactly. See, the 4 \_\_\_\_\_. But only under certain conditions.  
**Intern:** I'm not sure I get 5 \_\_\_\_\_.  
**Engineer:** Let me explain. They 6 \_\_\_\_\_ with a light workload.

## Speaking

8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*Is that not true?*  
*What do you mean?*  
*I'm not sure ...*

**Student A:** You are an engineer. Talk to Student B about:

- a performance test
- how results are gathered
- challenges when assessing computer performance

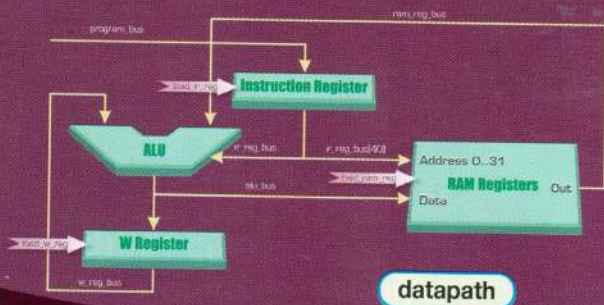
**Student B:** You are an intern. Talk to Student A about a performance test.

## Writing

9 Use the webpage and the conversation from Task 8 to write an evaluation of a computer's performance. Include: types of measurements that were used.







## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What devices are used in datapaths?
- 2 What are the three instruction classes?

## Reading

2 Read the textbook chapter. Then, choose the correct answers.

- 1 What is the chapter mostly about?
  - A the physical construction of a standard datapath
  - B the components and implementation of datapaths
  - C new advances in the hardware used in datapaths
  - D troubleshooting common datapath errors
- 2 Which is NOT a component of the datapath?
 

A ALU	C memory
B multiplexer	D PC
- 3 Which device stores the address of the next instruction?
  - A program counter
  - B instruction register
  - C data selector
  - D control unit

## Computer Design

### Datapaths

The term **datapath** refers to a series of devices that perform calculations. A **control** distributes program instructions to the datapath, memory, and I/O devices. We discussed control units previously in Chapters 1 and 3. Standard datapaths consist of a **PC** (program counter) and various small registers. Arithmetic logic units (**ALUs**) and simple **adders** perform basic arithmetic tasks. In some cases, there are multiple adders and ALUs performing calculations simultaneously. However, it is impractical to wire every possible I/O connection. Many datapaths solve this problem with a **multiplexer**, or **data selector**. Multiplexers transfer data from the correct input **source** to its **destination**.

The address of the current instruction is stored in an instruction register. Be careful not to confuse the instruction register with the PC. The PC stores the address of the next planned instruction, like a bookmark.

In order to understand **implementation**, we must understand the three **instruction classes**:

- **memory-reference** instructions read from memory or write data to memory
- **arithmetic-logical** instructions perform calculations
- **branch** instructions provide the PC with a new instruction address

Note that all three instruction classes make use of ALUs! Don't let the term 'arithmetic-logical' fool you.

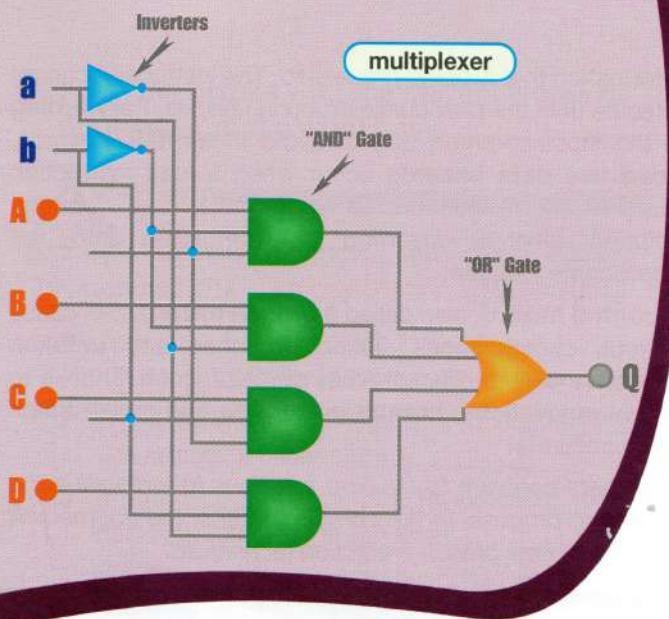
## Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |             |                         |
|-------------|-------------------------|
| 1 __ PC     | 5 __ datapath           |
| 2 __ ALU    | 6 __ multiplexer        |
| 3 __ adder  | 7 __ implementation     |
| 4 __ branch | 8 __ arithmetic-logical |

- A an instruction that tells the datapath to perform mathematical operations
- B a device that chooses from several inputs and sends to a single output
- C a circuit that carries out arithmetic and logical operations
- D a register that stores the address of the next instruction
- E the process of carrying out a task in a certain way
- F a series of units that perform data processing tasks
- G an instruction that changes the instruction address in the PC
- H a circuit that performs addition operations





**4** Read the sentence pairs. Choose which word or phrase best fits each blank.

**1 control / instruction class**

- A The \_\_\_\_\_ gives instructions to the datapath.
- B \_\_\_\_\_ is a category for types of instructions.

**2 memory-reference / data selector**

- A A \_\_\_\_\_ chooses the right input and sends it to its destination.
- B A \_\_\_\_\_ instruction reads or writes information.

**3 source / destination**

- A The \_\_\_\_\_ is where information comes from.
- B The \_\_\_\_\_ is where the information is going.

**5** Listen and read the textbook chapter again. Why do datapaths use a multiplexer?

**Listening**

**6** Listen to a conversation between a student and an instructor. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The woman is confused about the purpose of the control.
- 2 \_\_\_ The woman correctly identifies the first step in datapath instructions.
- 3 \_\_\_ The man recommends that the woman read the chapter on ALUs again.

**7** Listen again and complete the conversation.

**Student:** Well, I know that the **1** \_\_\_\_\_ gives the instructions. But I don't really understand the data flow.

**Instructor:** Like you said, the control gives instructions to the **2** \_\_\_\_\_. Do you know what the first step is?

**Student:** No, I don't.

**Instructor:** **3** \_\_\_\_\_.

**Student:** Is it having the **4** \_\_\_\_\_ fetch the next instruction?

**Instructor:** That's right. See, you understand better than you think you do. From there, we usually have to follow a **5** \_\_\_\_\_ - \_\_\_\_\_ instruction.

**Student:** Okay. Then what?

**Instructor:** Well, all **6** \_\_\_\_\_ use the ALU. So that's where the data goes next.

**Speaking**

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

- The first step is that ...*
- From there ...*
- I thought ...*

**Student A:** You are a student. Talk to Student B about:

- datapath implementation
- units involved in data processing
- concepts you are confused about

**Student B:** You are an instructor. Talk to Student A about datapath implementation.

**Writing**

**9** Use the textbook chapter and the conversation from Task 8 to write a teacher evaluation. Include: how an instructor helped you understand datapaths, what you were confused about, and what you learned.



# Pipeline Hazards

Article from the *Journal of Computer Programming and Engineering*

**Pipelining** is a standard technique for improving throughput. It works by **concurrently** operating all **stages** of an instruction set. Though it does not decrease **latency**, it dramatically reduces throughput time. However, concurrent operations create a number of potential **hazards** in the pipeline:

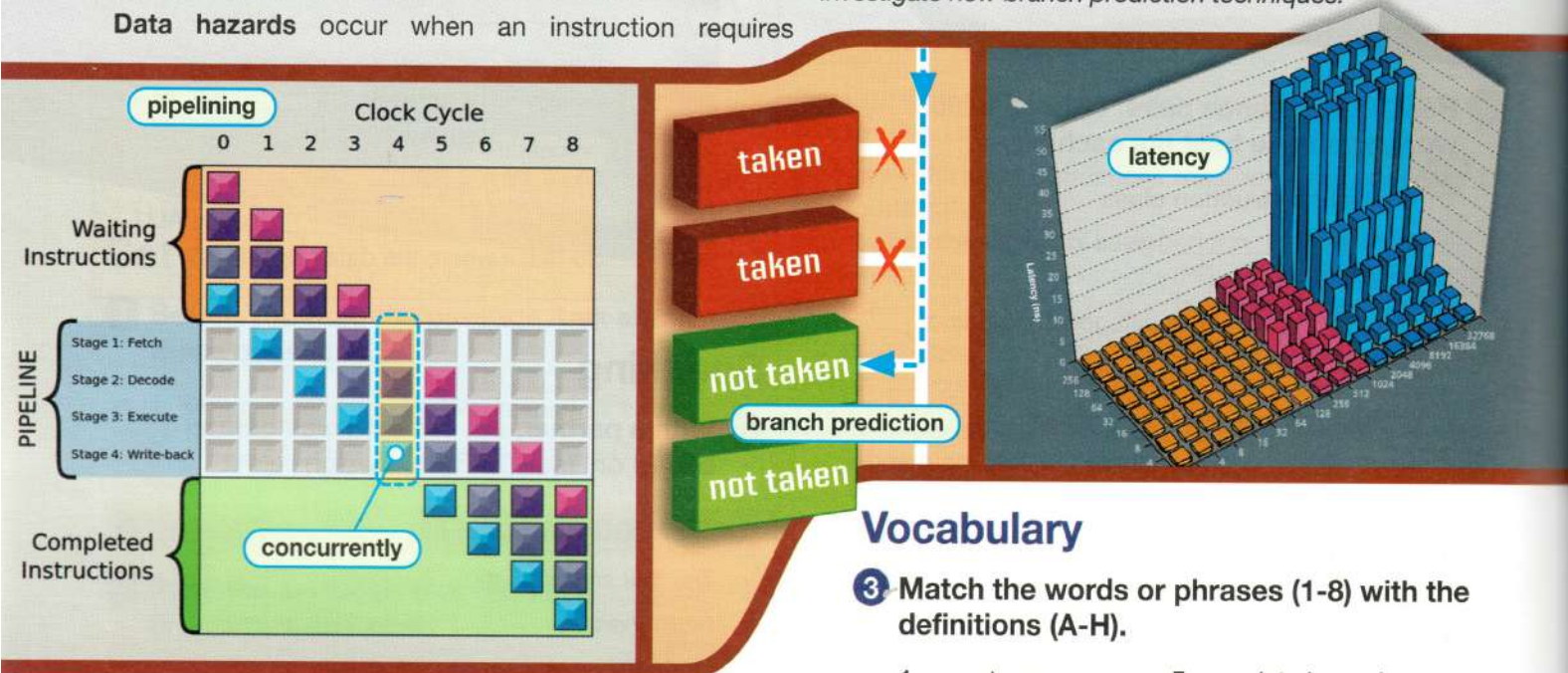
**Structural hazards** occur when the hardware is insufficient to accommodate all instructions. Unfortunately, it is impossible to predict what machines private users will own. **Pipeline stalls** can reduce the risk of structural hazards.

**Data hazards** occur when an instruction requires

information that is being processed. The instruction cannot execute until the previous instruction finishes. **Forwarding** is the most common way to avoid these data hazards. **Load-use data hazards** occur when a load instruction requires information that is unavailable. One common solution involves inserting pipeline stalls into the appropriate location.

A **control hazard**, also called a **branch hazard**, can cause serious complications. Taken branches and **untaken branches** lead to different areas of the program. Thanks to recent innovations, **branch prediction** has grown much more accurate.

*Engineers continue to develop solutions to streamline the pipelining process. In the coming months, the Journal will investigate new branch prediction techniques.*



## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What is the purpose of pipelining?
- 2 What types of hazards occur in pipelining?

## Reading

2 Read the journal article. Then, mark the following statements as true (T) or false (F).

- 1 \_\_\_ Pipelining dramatically reduces latency.
- 2 \_\_\_ According to the article, forwarding is the most common way to avoid load-use data hazards.
- 3 \_\_\_ Branch prediction helps prevent control hazards.

## Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |                    |                            |
|--------------------|----------------------------|
| 1 ___ stage        | 5 ___ data hazard          |
| 2 ___ latency      | 6 ___ control hazard       |
| 3 ___ pipelining   | 7 ___ branch prediction    |
| 4 ___ concurrently | 8 ___ load-use data hazard |

- A a specific task or action in an overall process  
 B a situation in which the data needed for an instruction is not available  
 C the time required to execute an individual instruction  
 D at the same time  
 E a situation in which the information needed for a branch is not available  
 F the act of guessing whether a branch will be taken  
 G a technique for implementing multiple instructions simultaneously  
 H a situation in which the data for a load instruction is not available



- 4 Fill in the blanks with the correct words or phrases from the word bank.

### Word BANK

hazard    untaken branch    structural hazard  
branch hazard    pipeline stall    forwarding

- 1 A(n) \_\_\_\_\_ occurred when there were not enough adders to carry out instructions.
- 2 When the information needed for a branch is unavailable, it causes a(n) \_\_\_\_\_.
- 3 In a(n) \_\_\_\_\_, the PC proceeds to the next instruction in the sequence.
- 4 A(n) \_\_\_\_\_ is a situation in which the planned instruction cannot be executed.
- 5 In order to avoid data hazards, most systems use \_\_\_\_\_.
- 6 The engineers encountered a structural hazard, so they implemented a(n) \_\_\_\_\_.

- 5 Listen and read the journal article again. When do computer programmers implement pipeline stalls?

## Listening

- 6 Listen to a conversation between two computer engineers. Choose the correct answers.

- 1 What is the conversation mostly about?
  - A a hazard in a data pipeline
  - B a sudden increase in latency
  - C a new pipelining approach
  - D an error in forwarding
- 2 What will the man likely do next?
  - A draw a diagram of a new pipeline
  - B research control hazard solutions
  - C implement an additional pipeline stall
  - D use more effective branch prediction

- 7 Listen again and complete the conversation.

- Engineer 1:** Hey, April. It looks like we've got some kind of **1** \_\_\_\_\_ here.
- Engineer 2:** That's not good. Where did you find the problem?
- Engineer 1:** It's the program we worked on yesterday. We just implemented the **2** \_\_\_\_\_ and it's not working correctly.
- Engineer 2:** Well, that's not uncommon. Which **3** \_\_\_\_\_ failed to execute?
- Engineer 1:** The first problem is with this load instruction. It looks like a **4** \_\_\_\_\_.
- Engineer 2:** Did you add a **5** \_\_\_\_\_?
- Engineer 1:** Yeah, but it didn't seem to change anything. That's why I'm confused.
- Engineer 2:** Hmm. May I **6** \_\_\_\_\_?

## Speaking

- 8 With a partner, act out the roles below based on Task 7. Then, switch roles.

### USE LANGUAGE SUCH AS:

*It looks like ...*

*It might have been ...*

*That makes sense.*

**Student A:** You are an engineer. Talk to Student B about:

- a hazard in a pipeline
- what type of hazard occurred
- how to resolve the problem

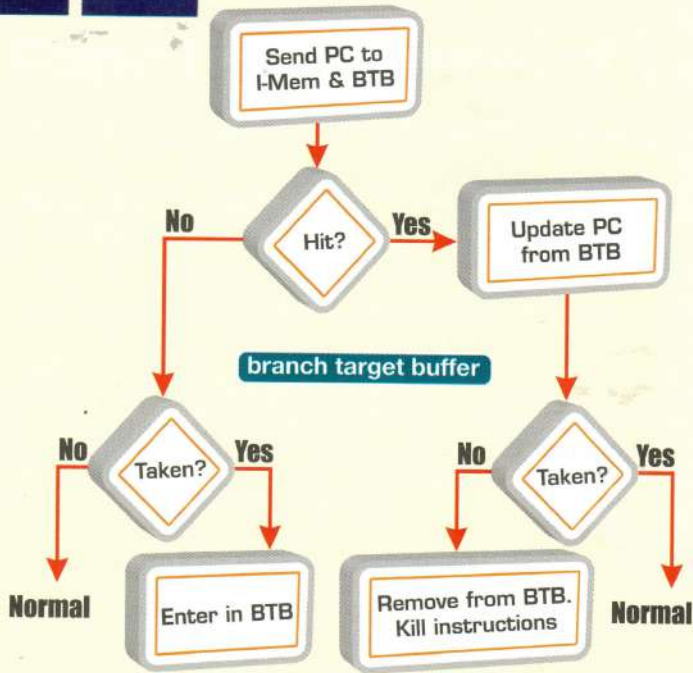
**Student B:** You are an engineer. Talk to Student A about a pipeline hazard.

## Writing

- 9 Use the journal article and the conversation from Task 8 to write an error resolution report. Include: a type of hazard that occurred, what steps were taken to correct it, and whether or not the issue was resolved.



# 10 Pipelining 2



## Pipelines (CONTINUED)

As indicated in previous chapters, the challenge of pipelining is avoiding hazards. In addition to **bubbles**, we can also use **NOPs**. In essence, a NOP (No Operation) is an instruction that does nothing. In this respect, it functions very much like a pipeline stall. However, constantly bubbling the pipeline does not ensure smooth execution of instructions. In the case of branch instructions, we need to use branch prediction.

Branch prediction allows us to guess whether a branch will be taken. When the prediction is wrong, we simply **flush instructions** and start over. But flushing instructions takes up valuable time. Fortunately, there are a number of advanced branch prediction methods.

**Dynamic branch prediction** involves looking up whether a branch was recently taken. This information is stored in a **branch history table**, or **branch prediction buffer**. A **correlating predictor** operates similarly, but also looks up global branch data. **Tournament branch predictors** are the most useful because they provide more options.

But even an advanced predictor will never be totally accurate. Keeping a NOP in the **branch delay slot** can help eliminate penalties. Another approach is to store the branch destination in a **branch target buffer**. This reduces the time needed to retrieve branch information.

### Get ready!

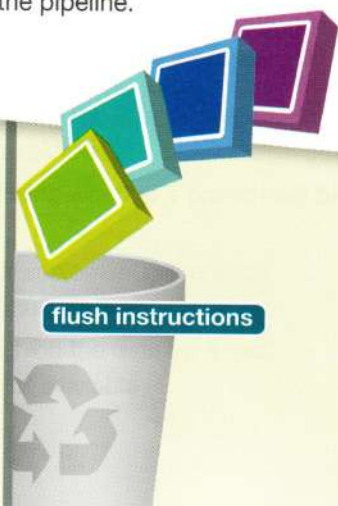
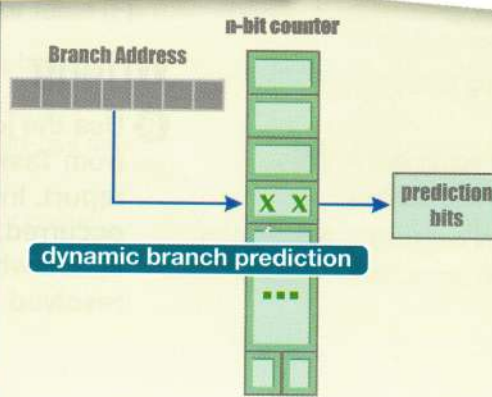
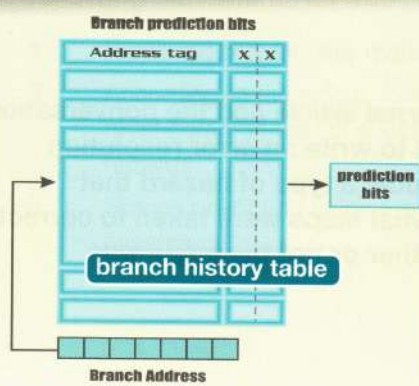
1 Before you read the passage, talk about these questions.

- 1 What are some types of branch prediction?
- 2 What is the purpose of a NOP?

### Reading

2 Read the textbook chapter. Then, choose the correct answers.

- 1 What is the chapter mostly about?
  - A problems with early methods of branch prediction
  - B ways to avoid flushing instructions from the pipeline
  - C how branch prediction makes pipelining more efficient
  - D the differences between NOPs and pipeline stalls
- 2 What is the function of a branch history table?
  - A It looks up global data about recently taken branches.
  - B It stores data about whether a branch was recently taken.
  - C It records the destination of the next branch.
  - D It calculates the accuracy of branch prediction.
- 3 Which idea is NOT mentioned in the passage?
  - A Instructions are flushed from the pipeline when a prediction is wrong.
  - B Tournament branch predictors are more versatile than other predictors.
  - C Correlating predictors use local and global data about taken branches.
  - D NOP instructions are executed in inactive stages of the pipeline.





## Vocabulary

### 3 Match the words or phrases (1-7) with the definitions (A-G).

- 1 \_\_\_ NOP  
 2 \_\_\_ flush instructions  
 3 \_\_\_ correlating predictor  
 4 \_\_\_ branch target buffer  
 5 \_\_\_ branch delay slot  
 6 \_\_\_ branch history table  
 7 \_\_\_ tournament branch predictor
- A a cache that stores the next instruction for a taken branch  
 B a branch predictor that uses local and global data  
 C a space containing the first instruction that will be executed after a branch  
 D a small memory that records whether a branch was recently taken  
 E an instruction that does nothing  
 F a branch predictor that has multiple prediction types to choose from  
 G to discard all current instructions

### 4 Read the sentence and choose the correct words or phrases.

- 1 The **branch prediction buffer / correlating predictor** contains information about whether a branch was recently taken.  
 2 Some hazards can be resolved by inserting a **bubble / branch delay slot** into the pipeline.  
 3 **Branch target buffer / Dynamic branch prediction** uses information about recently taken branches.

### 5 Listen and read the textbook chapter again. Why is a branch target buffer useful?

## Listening

### 6 Listen to a conversation between an instructor and a student. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The man used too many bubbles.  
 2 \_\_\_ The woman suggests using dynamic branch prediction.  
 3 \_\_\_ The woman advises the man to flush instructions.

### 7 Listen again and complete the conversation.

- Instructor:** I can see that you have 1 \_\_\_\_\_ inserted in all the right places. But you need to use better branch prediction.
- Student:** Okay. How do I do that? Should I use 2 \_\_\_\_\_?
- Instructor:** In this case, that's the best option. It'll look up information from the 3 \_\_\_\_\_.
- Student:** All right.
- Instructor:** But don't forget, you'll still have to 4 \_\_\_\_\_ when the branch prediction is wrong.
- Student:** 5 \_\_\_\_\_ by that?
- Instructor:** Well, the program might execute instructions based on a wrong prediction. So you have to 6 \_\_\_\_\_ those instructions.
- Student:** Oh, I see.

## Speaking

### 8 With a partner, act out the roles below based on Task 7. Then, switch roles.

#### USE LANGUAGE SUCH AS:

*How do I do that?*

*Don't forget to ... / What do you mean ...?*

**Student A:** You are an instructor. Talk to Student B about:

- a pipelining assignment
- what problems he or she encountered
- your advice for resolving the problem

**Student B:** You are a student. Talk to Student A about a pipelining assignment.

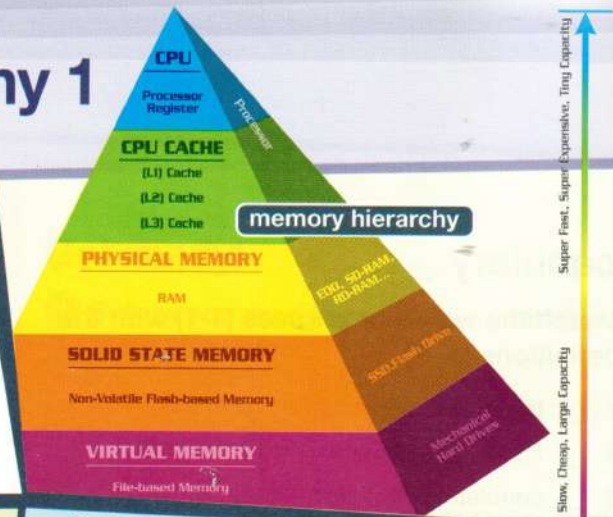
## Writing

### 9 Use the textbook chapter and the conversation from Task 8 to write a student assessment. Include: a review of the student's pipelining assignment, problems he or she had with a pipeline, and how he or she resolved the problems.



## Get ready!

- Before you read the passage, talk about these questions.
  - What is a memory hierarchy?
  - What are the principles of temporal and spatial locality?



## CompDIY The do-it-yourself computer forum

### Topic: Memory Hierarchy

#### Post

**JackieN** I'm currently building my first computer. Some of my friends told me to create a **memory hierarchy**. What is memory hierarchy, and how does it work?

#### Total Replies: 2

**Craig32** A memory hierarchy is a way of arranging memory into multiple levels. The top level is SRAM, followed by layers of DRAM. The bottom level is your magnetic disk.

At any one time, we only use a small percentage of the memory. (This is the **principle of locality**.) So we put the data we're most likely to need in the cache. Programs will fill the cache based on **temporal locality** and **spatial locality**. That way, we can **reference** the data we need quickly. Without the memory hierarchy, the **access time** would be a lot longer.

Hope that answers your question. :)

**TRalston1991** You should also look up memory accesses. A memory access is classified as either a **hit** or a miss. A miss occurs when the **block** you need isn't in the cache. You want your **hit rate** to be as high as possible. Make sure the **miss rate** isn't higher than the hit rate. **Miss penalties** can slow down your processor by a lot. You also want to keep your **hit time** down. Good luck!

Access Type	Sequential (ms)	Random (ms)
512 KB Read	4.06	13.28
512 KB Write	4.18	9.06
4 KB Read	0.18	7.47
4 KB Write	0.19	3.35

## Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |                |                            |
|----------------|----------------------------|
| 1 __ hit       | 5 __ reference             |
| 2 __ block     | 6 __ miss penalty          |
| 3 __ hit rate  | 7 __ memory hierarchy      |
| 4 __ miss rate | 8 __ principle of locality |

- A a situation in which the requested data is present in the cache
- B a concept that states that only a small amount of memory is used at one time
- C the smallest unit of data that can exist in a level of memory
- D the extra time required to retrieve data from lower levels of memory
- E a system for organizing memory into multiple tiers
- F the percentage of memory accesses found in the cache
- G to open or recall something from its data location
- H the percentage of memory accesses not found in the cache

## Reading

2 Read the message board. Then, mark the following statements as true (T) or false (F).

- \_\_ The original post explains how a memory hierarchy works.
- \_\_ According to the message board, computer users want high hit rates.
- \_\_ The second reply corrects an error in the first reply.



**4** Read the sentence pairs. Choose which phrase best fits each blank.

**1 access time / hit time**

- A The \_\_\_\_\_ is the time needed to determine if a block is in the cache.  
 B The \_\_\_\_\_ is the time required to retrieve data from memory.

**2 temporal locality / spatial locality**

- A We place recently used addresses in the cache based on \_\_\_\_\_.  
 B Sequential addresses are in the cache based on \_\_\_\_\_.

**5** Listen and read the message board again. According to the first reply, why is a memory hierarchy important?

## Listening

**6** Listen to a conversation between two engineers. Choose the correct answers.

- 1 What is the conversation mostly about?  
 A the differences between types of localities  
 B a problem with the function of a program's memory  
 C an upcoming presentation about reducing access time  
 D recent improvements in hit and miss rates
- 2 What will the man likely do next?  
 A adjust the program to use more spatial locality  
 B install an extra cache in the memory hierarchy  
 C send a report to a colleague about the hit rate  
 D calculate the program's average hit time

**7** Listen again and complete the conversation.

- Eng. 1: I had a feeling that might be the case. Did the  
 1 \_\_\_\_\_ go up, at least?
- Eng. 2: Nope. The hit rate is 2 \_\_\_\_\_ than it was before.  
 The miss penalties are really slowing things down.
- Eng. 1: Well, it sounds like we've got a problem there. Are we using  
 3 \_\_\_\_\_ to fill the cache?
- Eng. 2: Yeah, but in this case it doesn't seem to be a good choice.
- Eng. 1: Well, let's improve the 4 \_\_\_\_\_. Is that what  
 you were thinking?
- Eng. 2: Yes, that's exactly what I was thinking.
- Eng. 1: With luck, that'll bring the 5 \_\_\_\_\_ down. Aside  
 from that, how do things look?
- Eng. 2: It's hard to say at this point. The 6 \_\_\_\_\_ is  
 reasonable, though.

## Speaking

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

*How's the program ...?*

*It's even higher/lower than ...*

*It sounds like ...*

**Student A:** You are an engineer.  
 Talk to Student B about:

- a program that he or she is currently working on
- problems with the memory that he or she encountered
- how to solve the problem

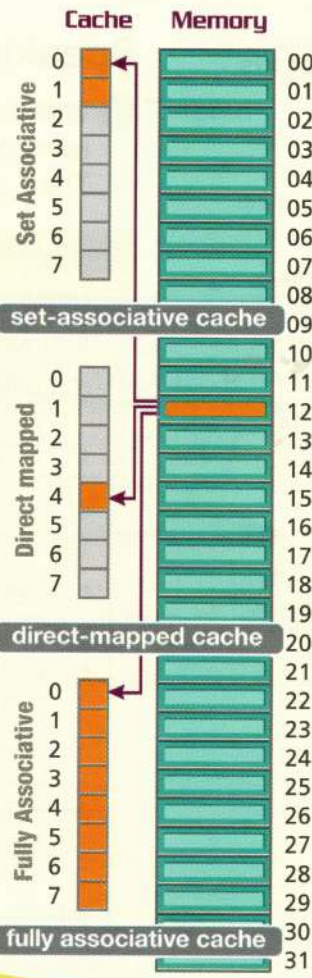
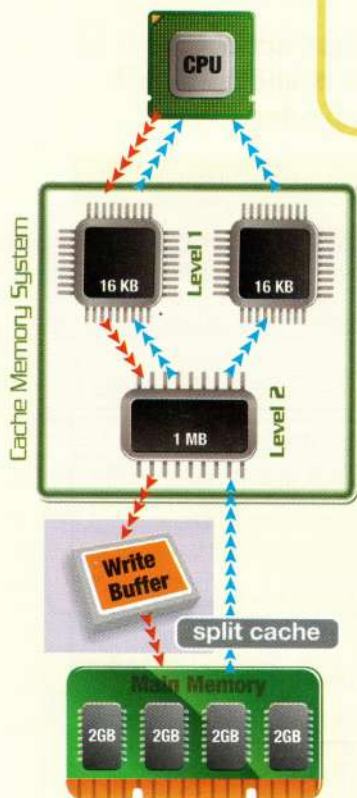
**Student B:** You are an engineer.  
 Talk to Student A about a problem with the program's memory.

## Writing

**9** Use the message board and the conversation from Task 8 to write a post on a computer engineering forum. Include: a problem an engineer encountered, what measures were already taken, and what the results were.



# 12 Memory Hierarchy 2



## Cache (computing)

A **cache** is a small, fast memory unit that stores instructions and active program data. The cache allows the CPU to **access** relevant information quickly and efficiently. There are several different cache setup schemes, each useful in different scenarios.

A **direct-mapped cache** assigns each memory location to a specific cache location. In a **fully associative cache**, any block may be placed in any location. A **set-associative cache** is the middle ground between the two extremes. A set-associative cache assigns a set number of potential block locations. Blocks of data are identified by **tags**, and verified by a **valid bit**. The valid bit indicates whether or not the tag is current.

A **split cache** is a memory setup that utilizes two **parallel** caches. One cache only **handles** instructions, while the other handles data. While split caches increase cache bandwidth, they increase the rate of **cache misses**.

Memory hierarchies have various ways to keep data **consistent** between the cache and the main memory. One method is **write-through**, in which both are updated simultaneously. Write-through is effective, but slow. Some systems utilize a **write buffer** (a small **queue**) to streamline the process. Another solution is **write-back**.

A write-back scheme updates the memory only after the cache entry is replaced with new information.

### Get ready!

1 Before you read the passage, talk about these questions.

- 1 What are some different types of caches?
- 2 How can programmers ensure that the cache and the memory are consistent?

### Reading

2 Read the encyclopedia entry. Then, mark the following statements as true (T) or false (F).

- 1 \_\_\_ A tag identifies the valid bit as current or not current.
- 2 \_\_\_ Cache misses are increased when a programmer uses a split cache setup.
- 3 \_\_\_ In a write-back, the cache and memory are updated at the same time.

### Vocabulary

3 Match the words or phrases (1-8) with the definitions (A-H).

- |                   |                               |
|-------------------|-------------------------------|
| 1 ___ tag         | 5 ___ write-through           |
| 2 ___ cache miss  | 6 ___ direct-mapped cache     |
| 3 ___ split cache | 7 ___ set-associative cache   |
| 4 ___ write-back  | 8 ___ fully associative cache |

- A a cache that assigns each block to a specific cache location
- B a memory setup that uses two parallel caches
- C a marker that identifies the contents of a block
- D a cache in which any block can be placed in any location
- E a process for updating the cache and the memory simultaneously
- F a situation when the requested block is not in the cache
- G a cache in which a block can be placed in a fixed number of locations
- H a process for updating memory only when the cache block is replaced



**4** Read the sentence pairs. Choose which word or phrase best fits each blank.

**1 queue / cache**

- A A \_\_\_\_\_ is the small, fast memory closest to the CPU.
- B A \_\_\_\_\_ is a series of blocks waiting to be processed.

**2 valid bit / write buffer**

- A The \_\_\_\_\_ helps to prevent processor stalls.
- B The \_\_\_\_\_ identifies a cache entry as current.

**3 handle / access**

- A The control will \_\_\_\_\_ information from the memory.
- B The processor couldn't \_\_\_\_\_ the request.

**4 consistent / parallel**

- A The memory and the cache should be \_\_\_\_\_ with one another.
- B A split cache uses two \_\_\_\_\_ caches.

**5** Listen and read the encyclopedia entry again. What does the valid bit do?

**Listening**

**6** Listen to a conversation between two computer engineers. Choose the correct answers.

- 1 What is the conversation mostly about?
  - A the implementation of a direct-mapped cache
  - B the challenges of working with a split cache
  - C a new development in the use of write buffers
  - D a problem with cache-memory consistency
- 2 What will the woman likely do next?
  - A reset the valid bits for the program
  - B install a fully-associative cache
  - C implement a write buffer with the program
  - D switch the program to a write-through scheme

**7** Listen again and complete the conversation.

**Engineer 1:** Ray, I was hoping you could 1 \_\_\_\_\_.

I know you have a lot more experience with this than I do.

**Engineer 2:** Sure, Nell. Are you still having problems with that 2 \_\_\_\_\_?

**Engineer 1:** Yeah, I'm getting a lot of cache misses. And sometimes the processor can't 3 \_\_\_\_\_ at all.

**Engineer 2:** Let's have a look. Is this a 4 \_\_\_\_\_?

**Engineer 1:** No, it's a 5 \_\_\_\_\_ - \_\_\_\_\_.

**Engineer 2:** Ah, I see. Okay, it looks like the cache and the memory aren't 6 \_\_\_\_\_.

**Speaking**

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

- I was hoping you could give me a hand.*
- It looks like ...*
- Should I ...?*

**Student A:** You are an engineer. Talk to Student B about:

- a problem with cache function
- the cause of the problem
- his or her recommended solution

**Student B:** You are an engineer. Talk to Student A about a problem with cache function.

**Writing**

**9** Use the encyclopedia entry and the conversation from Task 8 to write an email to a senior engineer. Include: the original problem, the measures taken to solve it, and the resolution to the problem.

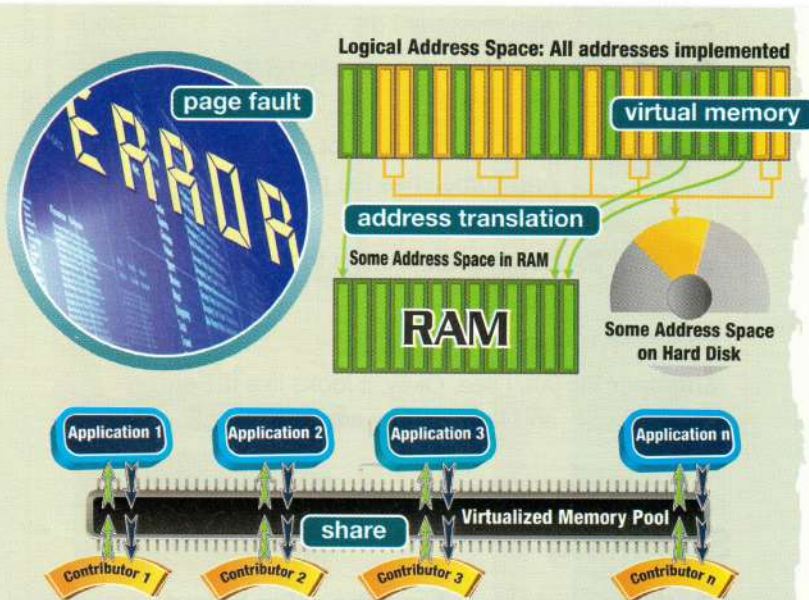


# 13 Virtual Memory

## Get ready!

1 Before you read the passage, talk about these questions.

- 1 Why do programmers use virtual memory?
- 2 How does address translation work?



## Unit 5.3 Virtual Memory & Paging

### What is virtual memory?

**Virtual memory** allows multiple programs to share memory safely and effectively.

*Remember: Like caches, virtual memory operates on the principle of locality.*

In order to keep programs isolated, each program receives its own **address space**. Virtual memory translates the **virtual addresses** into the real or **physical addresses**. **Address translation** provides **protection** from interference by other programs.

An individual block of virtual memory is referred to as a **page**. To locate a page, the processor references the program's **page table**. This index of address translations is different for every program. The OS creates a **swap space** to store all pages for a program. This data structure is often included in the page table. Some processors use a **TLB** (translation-lookaside buffer) to streamline memory access by avoiding the page table.

*The alternative to paging is **segmentation**, which we will discuss in Unit 5.4.*

In virtual memory, a miss is known as a **page fault**. To avoid costly page faults, we must replace pages effectively. An **LRU** (least recently used) **replacement scheme** is the most widely used method. Most machines use a **reference bit** to calculate LRU more accurately. While LRU is not the most accurate replacement scheme, it is efficient.

## Reading

2 Read the textbook chapter. Then, mark the following statements as true (T) or false (F).

- 1 What is the passage mostly about?
  - A troubleshooting problems with virtual memory
  - B the purposes of different virtual memory elements
  - C a comparison of types of virtual memory
  - D how to improve virtual memory on older machines
- 2 According to the passage, what is NOT true of page tables?
  - A They contain a list of address translations.
  - B They may contain an index of the swap space.
  - C They keep ongoing records of page faults.
  - D They are unique to a particular program.
- 3 How can programmers minimize page faults?
  - A implement LRU replacement
  - B reference the TLB instead of the page table
  - C create a well-defined swap space
  - D update the page table regularly

## Vocabulary

3 Match the words or phrases (1-9) with the definitions (A-I).

- |                    |                       |
|--------------------|-----------------------|
| 1 __ TLB           | 6 __ segmentation     |
| 2 __ share         | 7 __ address space    |
| 3 __ protection    | 8 __ physical address |
| 4 __ swap space    | 9 __ LRU replacement  |
| 5 __ reference bit | scheme                |

- A a field that indicates whether a page was recently accessed
- B a memory location for a specific program
- C an area of the disk set aside for virtual pages of a process
- D to allow others to use something at the same time
- E a variable-size address mapping setup
- F a cache containing recent address translations
- G the process of ensuring processes cannot interfere with each other
- H a memory address within the main memory
- I a method for changing out blocks or pages in a cache based on use



**4** Write a word or phrase that is similar in meaning to the underlined part.

- The basis of virtual memory is the process of converting a virtual address to a physical address.  
\_d\_\_e\_s t\_\_ns\_\_i\_n]
- In order to find a page, we reference the index of virtual and physical addresses. \_\_g\_ \_ab\_\_
- The act of using main memory as a cache makes programming easier. v\_\_u\_a\_ \_\_or\_
- The processor found the block of virtual memory in the main memory. \_\_\_e
- The address that the program sees is not the actual memory location. \_ir\_u\_l \_\_dr\_s\_
- A situation in which the requested page is not in the memory comes with a high penalty. p\_g\_ \_au\_\_

**5** Listen and read the textbook chapter again. How are programs kept isolated?

## Listening

**6** Listen to a conversation between two students. Mark the following statements as true (T) or false (F).

- The students are reviewing the results of a recent test.
- Processors access virtual addresses from the page table.
- LRU replacement schemes use reference bits.

**7** Listen again and complete the conversation.

- Student 1:** I don't think so. Professor Brown said it would only cover 1 \_\_\_\_\_.
- Student 2:** That's good. Will you quiz me on these 2 \_\_\_\_\_ terms?
- Student 1:** Sure. What is the process of converting a virtual address to a 3 \_\_\_\_\_?
- Student 2:** That's 4 \_\_\_\_\_.
- Student 1:** Right. Okay, I have a question. What exactly is a 5 \_\_\_\_\_?
- Student 2:** 6 \_\_\_\_\_ the address that the program sees. It corresponds to the physical address in the memory.

## Speaking

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

*Do you think ...?*

*I have a question ...*

*That refers to ...*

**Student A:** You are a student. Talk to Student B about:

- an upcoming exam
- what concepts will be on the exam
- what concepts you are confused about

**Student B:** You are a student. Talk to Student A about an upcoming exam.

## Writing

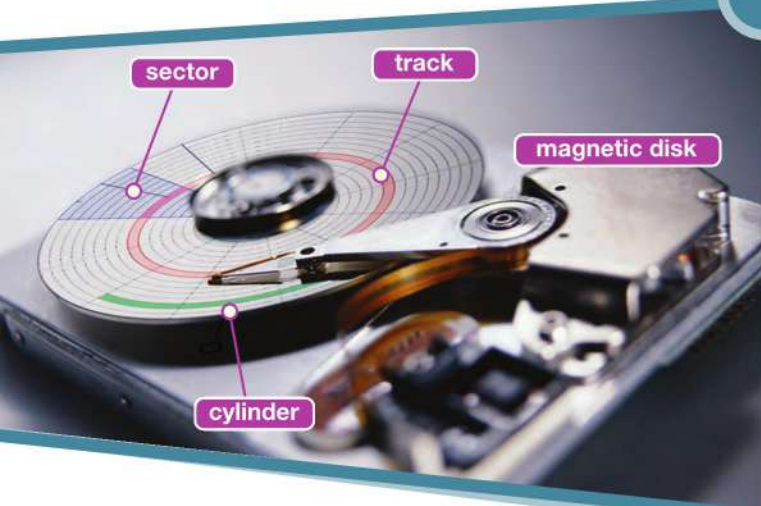
**9** Use the textbook chapter and the conversation from Task 8 to write an email from a student to an instructor. Include: the concepts that will be on the upcoming test, what the student has studied, and what concepts are still unclear.



# 14 Disk Storage

## Get ready!

- 1 Before you read the passage, talk about these questions.
  - 1 How do magnetic disks organize data?
  - 2 What kind of redundancy schemes are there for magnetic disks?



## Reading

- 2 Read the journal article. Then, mark the following statements as true (T) or false (F).
  - 1 What is the main idea of the article?
    - A changes in disk storage methods over the years
    - B the advantages of magnetic disk storage methods
    - C challenges of using magnetic disk storage for secondary memory
    - D ways to prevent disk storage failures
  - 2 Which is NOT true of RAID configuration?
    - A It is an efficient alternative to striping.
    - B It sometimes requires hot swapping.
    - C It uses standby spares to replace failed disks.
    - D Its disks can be organized into protection groups.
  - 3 Why is mirroring so expensive?
    - A It requires the organization of additional protection groups.
    - B It makes hot swapping necessary when disks fail.
    - C It requires a duplicate disk for every data disk.
    - D It is usually combined with the use of standby spares.

## Excerpts from:

# Magnetic Disk Storage and RAID Configurations

by Dr. Gerald Hart, Ph.D  
Article from the  
*International Journal of  
Computer Hardware  
and Engineering*

Despite advancement in SSDs, **magnetic disks** are still the standard for secondary memory. With fast **seek times** and low **rotational latency**, disk storage is highly efficient.

One of the advantages of magnetic disk storage is its data organization. The disk is divided into **tracks**, and tracks are divided into **sectors**. Some older machines also reference **cylinders**. A **seek** positions the read/write head over the correct track or cylinder. Most magnetic disks have a dedicated **disk controller** to improve performance. Magnetic disks will remain useful as long as **controller time** remains low.

Redundancy schemes for magnetic disks are called **RAIDs** (redundant arrays of inexpensive disks). RAID configurations are largely responsible for the practicality of magnetic disks. RAID 1, known as **mirroring**, is the most expensive RAID configuration. Mirroring requires a check disk for every active data disk. Other RAID configurations arrange data disks into **protection groups** to minimize hardware requirements. **Striping**, though referred to as RAID 0, has no actual redundancy.

No matter how efficient the RAID configuration, disks will fail and need replacement. While RAID configurations usually prevent system failures, **hot swapping** is a risky process. In order to avoid shutting down the system, some machines use **standby spares**. The standby spares remain inactive until a primary disk fails.



## Vocabulary

- 3 Match the words (1-7) with the definitions (A-G).

- |   |             |   |                       |
|---|-------------|---|-----------------------|
| 1 | __ seek     | 5 | __ mirroring          |
| 2 | __ track    | 6 | __ magnetic disk      |
| 3 | __ cylinder | 7 | __ rotational latency |
| 4 | __ striping |   |                       |
- 
- |   |  |
|---|--|
| A | all tracks that are underneath the read/write head                     |
| B | a type of nonvolatile memory that records data to rotating platters    |
| C | the time required to move the correct sector under the read/write head |
| D | the process of distributing sequential blocks to separate disks        |
| E | a single concentric circle on the surface of a disk                    |
| F | the process of recording identical data to two disks                   |
| G | the act of moving the read/write heads over the right track            |



**4** Read the sentence pairs. Choose which word or phrase best fits each blank.

**1 sector / seek time**

- A As disk technology advances, \_\_\_\_\_ decreases.  
 B Most magnetic disks can find the requested \_\_\_\_\_ quickly.

**2 RAID / disk controller**

- A \_\_\_\_\_ is a method for increasing performance and reliability.  
 B A \_\_\_\_\_ handles instructions and operations for the disk.

**3 protection group / controller time**

- A The engineers arranged redundancy with three disks to a \_\_\_\_\_.  
 B A high \_\_\_\_\_ can slow down the processor considerably.

**4 hot swapping / standby spare**

- A A \_\_\_\_\_ remains inactive until a data disk fails.  
 B \_\_\_\_\_ places high demands on the system during replacement.

**5** Listen and read the journal article again. What is the advantage of using standby spares?

**Listening**

**6** Listen to a conversation between two computer engineers. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The engineers are deciding on a RAID scheme.  
 2 \_\_\_ The woman would prefer to use mirroring.  
 3 \_\_\_ The project will use standby spares instead of hot swapping.



**7** Listen again and complete the conversation.

**Engineer 1:** Yeah, that's right. We know we'll be using **1** \_\_\_\_\_. But we need to decide on the level of redundancy.

**Engineer 2:** Right. So we have to decide what **2** \_\_\_\_\_ scheme to use?

**Engineer 1:** Yes. What are your thoughts?

**Engineer 2:** Well, I think we should use **3** \_\_\_\_\_. It's the most reliable.

**Engineer 1:** **4** \_\_\_\_\_. I don't think we can justify the cost of mirroring.

**Engineer 2:** But isn't it in budget? I **5** \_\_\_\_\_ the budget proposal just a few minutes ago.

**Engineer 1:** You're forgetting about the **6** \_\_\_\_\_. Part of that budget is needed for spare disks.

**Speaking**

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

- We need to decide ...*  
*I disagree ...*  
*You're forgetting ...*

**Student A:** You are an engineer. Talk to Student B about:

- disk storage for a new project
- what redundancy scheme to use
- why another scheme is not practical

**Student B:** You are an engineer. Talk to Student A about disk storage for a new project.

**Writing**

**9** Use the reading passage and conversation from Task 8 to write a report to a senior engineer. Include: the status of the new project, what disk configuration you plan to use, and why you chose that configuration.

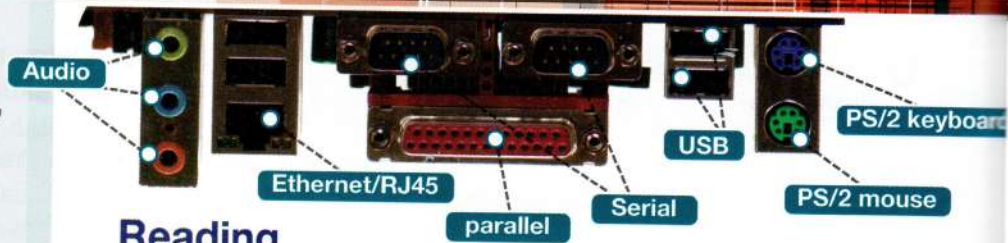


# 15 Buses

## Get ready!

1 Before you read the passage, talk about these questions.

- 1 What are some different types of buses?
- 2 What is the difference between synchronous and asynchronous buses?



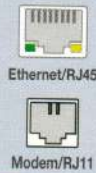
## Reading

2 Read the online encyclopedia article. Then, choose the correct answers.

- 1 What is the purpose of the article?
  - A to explain the history of buses in computers
  - B to compare buses made by two different companies
  - C to define some of the most common types of buses
  - D to give instructions for troubleshooting bus errors
- 2 According to the article, what is NOT true of buses?
  - A Parallel buses are more common than serial buses.
  - B Buses perform read and write transactions.
  - C Handshaking protocols are used in asynchronous buses.
  - D Processor-memory buses only connect two devices.
- 3 What is the advantage of synchronous buses?
  - A They are highly efficient.
  - B They use a handshaking protocol.
  - C They are designed to connect multiple peripherals.
  - D They use a split-transaction protocol.

## Buses (computing)

This is an article about computer interfaces. For the transportation method, see *Bus (vehicle)*.



Serial



Parallel



SCSI

In computing, a **bus** is an interface between different devices and subsystems. Buses are classified as either **serial buses** or **parallel buses**. The two types of buses transmit data differently. Some buses may be either parallel or serial. For example, an **SCSI** bus is typically parallel, but its protocol is sometimes implemented with serial buses.

### Bus Transactions



HDMI



PS/2

A bus transaction begins with a request. It may contain several communications. Bus transactions can be grouped into two categories: **read transactions** and **write transactions**. The specifics of the transaction depend on the devices using the bus. Some devices, for instance, can only accommodate read transactions.

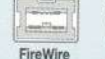
### Types of Buses



eSata



FireWire 400/Mb/s



FireWire 800/Mb/s

**Processor-memory buses** are short, fast buses optimized for processor-memory communications. Despite their high speeds, they are only used to connect two devices. I/O buses are designed to connect many different peripherals and internal devices. I/O buses usually communicate with memory using a **backplane bus**.

### Bus Communications



FireWire



USB

Bus communications are either **synchronous** or **asynchronous**. Synchronous buses are highly efficient. Devices connected to a synchronous bus must use the same clock rate.

Asynchronous buses use a **handshaking protocol** to coordinate data transmission. **FireWire** and **USB 2.0** are common examples of asynchronous clocking. Some asynchronous buses use a **split transaction protocol** to increase effective bandwidth.

Are you an expert in this subject? You can help by *expanding this article*.

## Vocabulary

3 Match the words or phrases (1-9) with the definitions (A-I).

- |                        |                                  |
|------------------------|----------------------------------|
| 1 ___ USB              | 6 ___ write transaction          |
| 2 ___ FireWire         | 7 ___ handshaking protocol       |
| 3 ___ backplane bus    | 8 ___ processor-memory bus       |
| 4 ___ bus transaction  | 9 ___ split-transaction protocol |
| 5 ___ read transaction |                                  |

- A a communication that records data to memory
- B a system in which both devices agree when to move to the next step
- C a bus that connects processors, memory, and I/O devices
- D a communication that requests data from memory
- E a high-speed bus that only connects two particular computer components
- F a system that can handle multiple requests to use the bus at one time
- G a standard interface for high-speed communications
- H a standard interface that is ideal for peripheral devices
- I a series of communications that begins with a request



**4** Read the sentence pairs. Choose which word or phrase best fits each blank.

**1 bus / SCSI**

- A A(n) \_\_\_\_\_ is a communication link between devices.  
B The disk drives in the PC use \_\_\_\_\_ connections.

**2 parallel bus / serial bus**

- A A \_\_\_\_\_ sends data one bit at a time.  
B A \_\_\_\_\_ sends multiple bits at a time.

**3 synchronous bus / asynchronous bus**

- A A(n) \_\_\_\_\_ uses a handshaking protocol.  
B A(n) \_\_\_\_\_ times communications with an internal clock.

**5** Listen and read the online encyclopedia article again. What is the difference between an I/O bus and a processor-memory bus?

## Listening

**6** Listen to a conversation between an intern and a computer engineer. Mark the following statements as true (T) or false (F).

- 1 \_\_\_ The man incorrectly identifies the purpose of asynchronous buses.  
2 \_\_\_ USB is a type of asynchronous bus.  
3 \_\_\_ The woman gives examples of parallel buses.

**7** Listen again and complete the conversation.

**Engineer:** Okay. Synchronous buses are what we use for **1** \_\_\_\_\_ - \_\_\_\_\_.

**Intern:** Right. And when do we use **2** \_\_\_\_\_?

**Engineer:** Well, asynchronous buses are useful for a wider variety of purposes. **3** \_\_\_\_\_ is a good example.

**Intern:** So would **4** \_\_\_\_\_ also be an asynchronous bus?

**Engineer:** Yes. And that also uses a **5** \_\_\_\_\_.

**Intern:** I can't remember how a handshaking protocol works.

**Engineer:** The two devices have to agree that the **6** \_\_\_\_\_ is finished. One purpose of a handshaking protocol is to verify this.

## Speaking

**8** With a partner, act out the roles below based on Task 7. Then, switch roles.

**USE LANGUAGE SUCH AS:**

*Do you have ...?*

*What do you need?*

*Let me get this straight ...*

**Student A:** You are an intern. Talk to Student B about:

- bus communications
- the differences between types of buses
- when particular buses are used

**Student B:** You are an engineer. Talk to Student A about bus communications.

## Writing

**9** Use the online encyclopedia article and the conversation from Task 8 to write an email to a supervising engineer. Include: topics from a previous conversation, concepts that are clear, and concepts that are still unclear.

